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Popular Electronics

DECEMBER 1993

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EDITORIAL

WHAT NEXT?

It's hard to believe that this is the last issue of **Popular Electronics** for 1993. It's been a fun and fascinating year for all of us here, and I hope it's been equally enjoyable for you.

We've tried some different things, and like all such endeavors, some worked really well; others less so. For the most part, our "theme" issues (Electric Cars, Satellite TV, Computers, Radio, Project-Builders Special, etc.) were well received and we plan to continue them for 1994; for example, the January, 1994 issue will feature weather-forecasting projects. However, ultimately this is still *YOUR* magazine. What is most important is that we provide what the majority of you readers want to see. With that in mind, I have a request:

Take a few minutes to leaf through this past year's issues. Then jot down which issues, articles, themes, etc. you found most useful and/or enjoyed the most, and which one's you liked least and/or found less useful, and send us your comments. We would also like you to let us know what areas you would like to see us cover more, and which areas you would like us to cover less. Even if you like things the way they are, write and let us know. (The address is: **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735).

I can't promise a personal response to everyone who writes. I can promise that I will read every letter, and that your input will help us shape the future course of this magazine. I look forward to hearing from you.

Before I close for the month, and the year, on behalf of everyone here at **Popular Electronics** I'd like to wish you a joyous holiday season and a happy New Year.

Carl Laron
Editor

LETTERS

COMPLEX-CALCULATOR PROBLEM

Soon after my "Complex Calculator" program was published (**Popular Electronics**, May 1993), several people wrote to me stating that they had problems getting it to run correctly. Being unable to find any mistakes in the printouts that they were kind enough to send, I decided it must be a legitimate programming error of some sort. I then retested the program for hours—dozens of hours. I could find no errors.

The next person to write explained exactly the problem he had encountered, and I immediately realized that there was an error associated with the program. It was not a programming error, nor a publishing error, nor an operator error. The error was one that is an inherent fact of life for digital computers: round-off error.

Digital computers have only a finite amount memory, so when they store numbers they must truncate the accuracy of the number to a certain degree. In the Complex-Calculator program, this manifested itself in such a way that users thought there was a programming error.

For example, when you follow the sample program run presented in the article, it instructs you to enter in memory-D the polar value magnitude 5 at an angle of 90%. Because the program stores all numbers in rectangular coordinates, it converted this polar value for D and then stored it in memory (and, hence, truncated it). When the program then needed to display the value in memory-D on the screen, it was not displayed with 100% accuracy. In the printout that one reader sent, the program displayed a REL value of -8.14034E-07, and an ANGLE value of 90.00002. That *very slight* discrepancy is round-off error; it is not the result of any errors in the program.

You might be able to reduce the effects of round-off error in the CMPX-CAL by using double precision numbers in the program, or by incorporating PRINT USING commands to display complete values on the screen. Consult your programming manuals for further information on these commands, and on the round-off phenomena in general.

Also, although it was not mentioned in the article, a shareware version of the CMPX-CAL program is available by sending a $10 registration fee and $2 shipping and handling to Aurora Software, Department X1, P. O. Box 080133, Rochester, MI 48308-0133. The program will be sent on a 5.25-inch, 360K format PC disk, and should arrive in four to six weeks.

Thanks to everyone who expressed an interest in the article, and I apologize for any frustrations you might have encountered due to round-off error.
JAMES E. TARCHINSKI

ELECTRIC CAR COSTS

Being an advocate of electric cars, and a follower of **Popular Electronics** since the age of 4 or 5 years (no lie!), I would like to throw a little curve into the "Go Electric!" discussion ("The EV Revolution Revs Up," April 1993, and "Letters," September 1993).

A little ballpark math, first. Let's assume that we are able to convert a significant percentage of the commuting populace to electric vehicles in say, 10 years. We could have 100 million "pollution-free" electric vehicles on the road, traveling an average of 60 miles a day to and from the office. 100 million units each consuming 15 kilowatt-hours of electricity for a grand total of 1.5 billion kWh of juice a day!

That's a lot of electricity! Where will it come from? It appears that coal will be a first choice as the international oil supply dwindles.

Now some more math. A coal-fired generating station, if tweaked to the max, is about 30% efficient at converting coal to electricity, resulting in approximately 1 kWh of electricity for every pound of coal that is fed. That's 1.5-billion pounds of coal a day. That's 547.5-billion tons of coal burned per year to run 100 million vehicles.

Now, if the same 100-million cars run the same distance at 30-miles-per gallon on gasoline, they would consume 200-million gallons of gas per day. That's 73-million gallons or 5,214,200 tons of gasoline (at 7 pounds/gallon) every year versus 547,500,000 tons of coal.

The local wholesale cost per ton of coal is $52, and gasoline is about $1.23 per gallon at the pumps. That gives a cost of $28.47 billion to run electric vehicles on electricity generated from coal and $12.82 billion dollars on gasoline. I have not been able to find current data on the amount of pollution per ton of coal versus ton of gasoline. Am I up in the night? This is one of those things that makes you go "Hmmm."

I also noted an article in *World Co-Generation Magazine* that predicts that, at current demand-increase curves, the nation's total electrical-generation capacity will not meet the demands by the year 2005 without significant increases in generation capacity. And no mention is made of the impact that 1.5 billion kWh/day would have on that prediction.

I guess the bottom line is we either rethink our lifestyle (*i.e.*, commuting to work), find a cheap, clean source of energy (solar? fusion?), or paint ourselves into a tough corner.
R.D.C.
Cedar City, UT

HAM IT UP!

I just got a peek at Karl T. Thurber's article, "What's a Ham?" (**Popular Electronics**, May 1993), and I wanted to tell you how impressed I was by it. If it doesn't single-handedly create a batch of new hams, I'll be surprised! The author managed to answer most of the frequently-asked questions that I get from reporters, and to do so in a way that was fun to read. Congratulations.

I was particularly interested in Mr. Thurber's thoughts on the origin of the word "ham." You might be interested to know that an older member recently wrote us to explain that "Ham" was short for "Hiram." And, of course, you know which Hiram he meant. (Well, maybe.)

My undergraduate philosophy professor used to urge us to apply Occam's Razor ("do not multiply entities without necessity") to these conundrums. So, with that concept in mind, maybe "ham" is just "am" as in "amateur." It's the simplest route to an explanation, but it sure is boring.

Keep up the good work!
Steve Mansfield, N1MZA
Public Information Manager
The American Radio Relay League
Newington, CT

HAVES & NEEDS

Do any readers know where I could find a schematic for a Gulbransen electric organ (no longer made), Model L, Serial No. 11703? Also, are there solid-state devices that could replace the tubes in the amplifier of the organ? The tubes are two 12AX7A's and four EL84/6B05's. Thanks for your help.
JAY W. HEDDEN
3911 W. 100 Terrace
Leawood, KS 66207

I have a little Sinclair RV, Model MTV1A, made in England. The picture tube is a Telefunken D5-100W, made in Germany. I need a schematic diagram for the power supply to light up the picture tube and a diagram of the picture-tube layout. Thank you in advance.
Sidney Smalls
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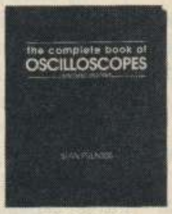
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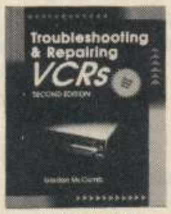
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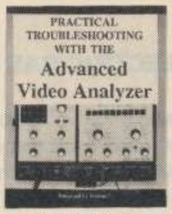
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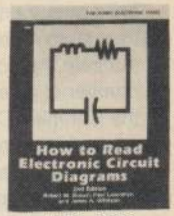
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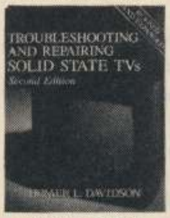
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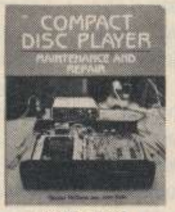
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DECEMBER 1993

GIZMO®

A CHRONICLE OF CONSUMER ELECTRONICS

HOLIDAY SHOPPING GUIDE

Deck the halls with electronic gizmos!

If visions of sugarplums and cheerful family get-togethers don't pop into your head when you're confronted with piped-in carols and garlands of tinsel before you've finished your Halloween candy, you're not alone. For many of us, the advent of the holiday season represents a mad rush of shopping and gift wrapping, cooking and cleaning, trimming and decorating, and party-giving and -going, and running charge cards to their limits. "Peace on Earth, good will toward men" never seems as unattainable as when you're trying to park at the mall in December! Shopping for the perfect gifts is no easy chore. Unless your family and friends are good hinters, it takes real insight to anticipate what would make them happy. And, unless you hand out a detailed "wish list" in advance, *gift getting* also can be tricky. Who hasn't opened a package that contained something so ugly, useless, or just plain silly that murmuring, "Oh, how nice!" without groaning (or laughing) was almost impossible. If you're lucky—and don't mind standing on line on December 26—you can return the stuff. Otherwise, it ends up gathering dust in the back of a closet until it gets recycled. This past summer, as we cleaned out closets, basement, and attic in preparation for a garage sale, we uncovered hordes of unwanted gifts ranging from a set of ceramic kitchen accessories—salt and pepper, napkin holder, cookie jar—all shaped like chickens, to an electric shoe-shining kit (inappropriate in a household whose footwear tends toward sneakers). There were strange board games, toys that had been marketed as "executive stress-busters," an incredibly ugly red leather hat with red fur ear flaps, several gourmet kitchen gadgets, and bottles of perfume and cologne—all unopened or unused. When almost all of it sold at the garage sale, we couldn't help wondering how much of it would end up under someone else's Christmas tree this year! That house-cleaning experience changed the way we look at gift-giving. From now on, we'll be shopping for quality instead of quantity, trying to give presents that will be used and appreciated for years to come. We're not the only ones to feel that way—"value" has become one of the buzzwords of the 90's. Put value together with "cocooning" (another big 90's buzzword), and you can see why it's becoming more common for families to buy themselves one big gift, something that they can all enjoy together, at home. A home-theater system fits that description perfectly. In fact, the consumer-electronics industry provides a wealth of items that you can be sure will be used, appreciated, and truly enjoyed. The price tags often seem high, but how about

SONY
MD
PHILIPS

chipping in with other family members to buy Mom a VCR that she can program by herself, or bring Dad into the digital age with his first CD player. (As a bonus; on future holidays you won't be at a loss for gift ideas—you can buy their favorite movies on videotape or LP's on CD.) Bring a long-distance, hard-to-reach sibling back in touch with the gift of an answering machine. Treat the family to an interactive entertainment system that everyone can use. Or upgrade your audio/video system to include surround sound. We can't promise you "Peace on Earth, good will toward men" but, to help you get through your holiday shopping with minimal fuss and bother, we've devoted this month's **Gizmo** to electronic gift ideas. We hope that with the following suggestions we can lessen the stress associated with aimlessly wandering the malls in search of the perfect gifts, as the countdown toward December 25th approaches. (Prices quoted are manufacturers suggested retail prices; street prices are often significantly lower.) Read on for gift ideas for your friends, family—and yourself.

THE SOUND (AND SHAPES) OF MUSIC

It's possible that no two people on your gift list have the same taste in music. But whether they prefer rap or classical, bebop or hip hop, folk rock or heavy metal, virtually everyone enjoys *listening* to some sort of music. If you're considering giving the gift of sound, there are choices galore—MiniDisc, Digital Compact Cassette, compact discs; personal players, boom-boxes, and mini- and micro-systems. For those who are firmly rooted in the past, how about a state-of-the-art turntable? Aesthetic-minded folks might be ready to trade in their boxy old speakers for some of today's small, distinctive styles. In fact, they might be ready to trade in their boxy old systems for something sleek and streamlined.

Bose Lifestyle 10

Heard, but not Seen

Music brightens any room in the house, but sound systems don't always fit the decor. *Bose Corporation* is noted for creating systems that sound great while remaining virtually invisible. Their *Lifestyle 10* is a two-zone system that can provide sound to more than ten rooms in each zone, allowing, for instance, a CD to play in the living room, dining room, kitchen, and den, while a tape or radio plays in the bedrooms. The RF remote included with the system controls the main unit even if it is tucked away behind closed doors or in another room of the house. The slim, unobtrusive center unit contains only music sources and system controls; amplifiers are relegated to the three-piece Acoustimass 5 Series II speaker system. The bulkiest part of the loudspeaker, the woofer, is contained in the bass module, a separate unit designed to be tucked out of sight. All the necessary amplification is built into the bass module. Thus, only the high- and mid-frequency drivers, which are packaged in tiny, sculpted, cube-shaped enclosures, remain visible. Listeners can adjust bass and treble to match room acoustics using room-compensation controls located on the bass module. *Ideal for anyone who loves music but hates clutter, or suffers from a lack of space*. Price: $1849.

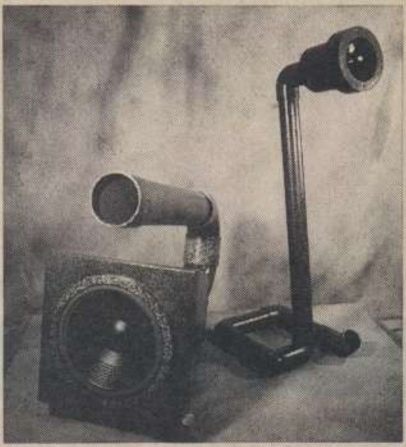
Aiwa Micro System

Micro System

For a more conventional look, *Aiwa* offers the *LCX-01*, a CD/tape/AM/FM system that is substantially smaller than conventional mini-systems. The unit's two pieces can be stacked or set side-by-side. The 30-watt (15 × 2) system includes a 20-track, random programmable CD player; an auto-reverse cassette deck; a digital synthesized tuner with 24 station presets; a full-featured remote control; and Dolby noise reduction. *A good gift for apartment or dormitory dwellers*. Price: $550.

Speakers as Art

There's more than one way to hide a speaker, and *Speaker-Sculpture* has come up with a unique way hide them in plain sight. Their three speaker designs bear no resemblance to any speaker we've ever seen—in fact, they look like modern-art sculptures. Despite their unusual configurations, the speakers are said to achieve the expansiveness, sharp imaging, and clarity of detail usually associated with much larger, more expensive speaker systems. The Speaker Sculptures, which can be powered by as little as five watts of power, are transmission-line loaded for rich bass and are designed to avoid such problems as diffraction, standing waves, crossover anomalies, and lack of coherence. Three styles are available: *The Snail* is a bookshelf-sized speaker system, *The Sea Horse* is wall-mounted, *The Cobra* is a free-standing pair of speakers, and *The Scorpion* is a subwoofer. *For the* artistes *on your list!* Prices: $200, The Snail; $400, The Sea Horse; $1500, The Cobra and The Scorpion three-piece set (pictured here).


Speaker-Sculpture

Ch-ch-ch-changes

Compact discs are firmly entrenched as the audio medium of choice, last year having finally surpassed cassettes in sales. The *CDC-835* five-disc changer from *Yamaha Electronics Corporation, USA* features "PlayXchange," which isolates the disc being played from those being stored in the changer drawer, to eliminate vibration and improve performance. That arrangement also allows the listener to replace any of the four discs in the tray while the fifth one plays. The CDC-835 uses Yamaha's "S-Bit Plus" enhanced single-bit digital-to-analog conversion system, said to improve low-level linearity and signal purity, and to provide cleaner high-frequency response, more ambience infor-

Yamaha five-disc changer

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mation, and a more defined sound stage. The changer has two DAC's per channel, one normal and one reverse phase, to eliminate noise caused by such external sources as unstable AC line current. The display automatically goes blank when the changer is in play mode, so as not to cause interference. Relay play allows two CDC-835's to be connected for uninterrupted 10-disc play. *Consider the CDC-835 for any discriminating listener who wants the convenience of a changer.* Price: $549.

Two-Dozen Discs

If five (or ten) is not enough, consider *Studio 24* from *Fisher*, which stores and plays back two-dozen compact discs. Studio 24 allows those discs to be categorized in a variety of ways. For instance, each member of a family of four could each keep their six favorite discs ready to be played. In other possible scenarios, one person might store discs by music type (jazz, rock), occasion (party mix 1, party mix 2), mood (morning music, romantic, upbeat), or simply by disc or artist name. Instructions for categorizing the discs scroll across the front-panel fluorescent display; an alphanumeric keyboard is used to input any category that hasn't been preprogrammed. The discs are stored and loaded vertically, and the laser pickup is mounted vertically, reducing dust buildup. *A good gift for the whole family, or anyone with a large, unwieldy CD collection.* Price: $499.95.

FISHER
Studio 24
24 TROCK 3

Fisher Studio 24

Esoteric Sound turntable

Everything Old is New Again

Let's face it: Some people are so firmly entrenched in their ways that there's no way to change them. We can understand, of course, why someone who has spent years amassing a collection of LP's and 45's—and perhaps even 78's—would be loathe to shelve them in favor of CD's. Those are precisely the people at whom *Esoteric Sound* aims its *Ramses* turntable. The belt-drive turntable has six speeds—33.33 and 45 rpm plus four speeds ranging from 71.29 to 80 rpm, the actual speeds of the discs recorded in the "78" era. The turntable features pitch control, a stylus-illumination lamp, and a hinged dust cover. It also comes with a free magnetic pickup with both an LP and a "78" stylus. *Perfect gift for the collector of vintage (and not-so-vintage) vinyl (and shellac) records.* Price: $425.

Sony MiniDisc Walkman

Digital Delight

There are also those folks who are ready to trade in the old at the first hint of something "new and improved." In the consumer-electronics industry, they're known as early adopters, and they're very well liked! For the early adopters on your list, forget CD's (don't even think about records!) and head straight for MiniDisc. *Sony's* MZ-1 MiniDisc Walkman player/recorder combines the sound quality and random access of compact discs with the no-skip portability of audio cassettes. *Ideal for anyone who agrees that Sony has come up with another winner.* Price: $749.95.

Sitting on the Fence

A more typical attitude toward change would probably be: "Gee, the new stuff sounds neat, but why can't it play my existing music collection?" The answer is: "It can!" That is: It can, *if* it happens to be DCC, or Digital Compact Cassette, a "backward-compatible" digital-audio medium. DCC decks play standard audio cassette tapes, and can play and record digital cassettes, with CD-quality sound. *Philips Consumer Electronics*, the inventor of DCC, now offers a portable unit that plays both analog and digital cassettes. The *DCC130* (which is shown on the first page of this guide) weighs just 1.1 pounds including battery, and provides skip-free, portable, digital audio for people on the go. A scrolling text display shows the artist name, album title, and track title. *A great gift for anyone who already has a home DCC deck and would like to enjoy digital tapes away from home.* Price: $549.

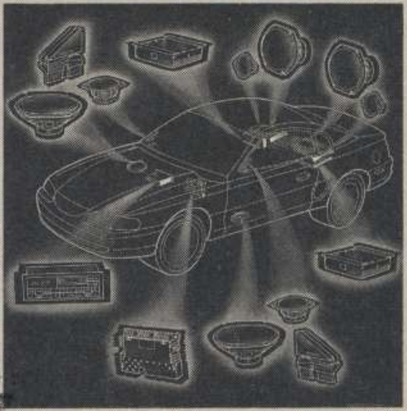
Foul-Weather Friend

Not all outdoor listening is done on portable personal players. Plenty of people enjoy music in their backyards, at poolside, or even while boating. The *Bose 151 Environmental Speaker* delivers high-quality sound even in the most inclement conditions. With a specially strengthened and weather-proofed speaker driver cone and surround, it was designed to withstand extremes of heat, cold, and humidity. The grille, terminal posts, and all hardware are made of stainless steel, to prevent deterioration from high humidity and salt water. The Environmental Speakers can be mounted outdoors on a sun deck, on a boat, at a lakeside cabin, or even hidden in the landscaping. The speakers measure 6 × 9 × 6 and come in black or white. *Ideal for the outdoorsman (or woman) in your life.* Price: $299.

Bose Environmental Speaker

One for the Road

If your pockets are deep, or there is someone *very* special on your Christmas list, you might consider giving them Ford's new Mustang. We've included it in the audio category because any 1994 Mustang that is equipped with the optional Electronic Stereo Cassette radio or the top-of-the-line Mach 460 audio system can be ordered with the industry's first factory-authorized, dealer-installed MiniDisc player. The MiniDisc player has a four-megabyte memory to hold up to 10 seconds of music data, virtually eliminating mistracking, even on the roughest roads. That's a comforting thought, considering that the sporty Mustang inspires fast driv-



Ford Mustang with MiniDisc

ing! *For the young—or young at heart—driver who just has to own the latest technology!* Price: expected to be about $12,000.

RADIO-ACTIVITIES

Since you're reading **Popular Electronics**, chances are there are some radio hobbyists on your shopping list—or there's some radio gear on your wish list. Circle the items you want and leave the magazine someplace where other family members are sure to stumble upon it!

Scan, Man!

A scanner is unmatched for bringing live action right to you. From police and other public-safety activities to military aircraft, all communications can be open to scanner users. *Radio Shack's Realistic PRO-43* handheld scanner (shown on page 5) offers 10 memory banks that can store up to 200 channels, which permits them to be grouped by type of service or by frequency. The search rate is 50 frequencies per second, and the scan rate is 25 channels per second. The receiving mode can be selected as AM or FM either manually or automatically. A charging circuit for nickel-cadmium batteries is built in. *For an active scanner user who needs a portable setup or for anyone looking to get into scanner monitoring.* Price: $349.99.

R.L. Drake R8 communications receiver

Shortwave Heavyweight

Although shortwave radio lacks the action of scanners, it can provide detailed information on world politics and fascinating glimpses of other societies, not to mention the thrill of hearing a radio broadcast from halfway around the world. Hardcore shortwave listeners will appreciate the high-tech features built into the *R8* general-coverage communications receiver from *R.L. Drake*. Among the features are an RS-232 serial interface for computer control, a 100-channel memory, a built-in pre-amp and attenuator, a synchronous detector for improved performance on AM signals, dual antenna inputs, and a passband offset control for pulling in weak signals in crowded bands. *For the demanding shortwave enthusiast.* Price: About $900.

Cobra CB radio

CB Lives!

Citizens Band radio, or CB, has certainly fallen out of the limelight since its heyday in the 1970's, but it still remains popular among many devotees, and it attracts new users every year. CB radio offers an economical alternative to cellular phones, especially when you consider how many car phones are being bought strictly for use in emergencies. *Cobra's 18 Ultra* mobile CB radio offers a built-in National Weather Service receiver and instant Emergency Channel 9 tuning. The front-firing speaker helps to broaden the installation choices available. *For anyone who spends a good deal of time on the road.* Price: $89.95

VIDEO VISIONS

Last year, a poll sponsored by *TV Guide* revealed that 46% of all Americans would refuse to "give up watching absolutely all types of television" for the rest of their lives for anything less than a cool million dollars. And 25% of those surveyed wouldn't give up the tube even for that amount. Those percentages suggest that you probably couldn't go wrong giving a TV to just about anyone on your list!

The only problem might be choosing the right set for the person. Today's TV's range in size from pocket-sized portable LCD's to huge rear-projection sets to separate front-projector/screen arrangements. Direct view sets are bigger than ever, having hit the 40-inch mark. True movie mavens will love the new 16:9 "letterbox" screens, available in a range of sizes. TVCR's—combination television/videocassette recorders—are becoming increasingly popular in dorm rooms, kitchens, and kid's rooms, and for anyone who would rather not bother with complicated connections between video components. And let's not forget the rest of the video field—VCR's, camcorders, laserdisc players, and A/V receivers all make great gifts.

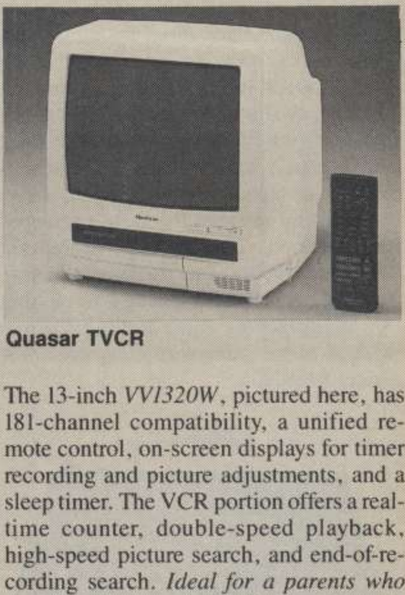
Sharp 4-inch LCD TV

Take-Out TV

Some people simply can't get through the day without TV. If you know who feels that way, but can't stay home in front of the TV, give them a TV that he can take along with him. *Sharp Electronics Corporation*, long a leader in LCD technology, designed their *4M-T30U* 4-inch, flat LCD television for the outdoor viewer. The flat-panel LCD provides a high-resolution image with a contrast ratio of more than 60:1. The set allows a wide viewing angle without any image retention or distortion, even in sunlight. The portable set features a built-in UHF/VHF tuner, mono sound, channel-select memory and automatic preset modes. Direct video and audio inputs make it easy to use as a monitor for a camcorder. The 4M-T30U can run on DC power, for use in cars or campers. *Makes a perfect gift for sports fanatics who hate to miss the instant replays when they're at the game, and families who enjoy camping or boating trips.* Price: $599.

Combination Station

When space is at a premium, and convenience is a priority, a combination television/VCR fits the bill. The all-in-one units require no hookup, are completely portable, and programming the VCR timer is generally a breeze. *Quasar Company* offers "Video Viewers" in both 13- and 20-inch sizes, in basic black or white. The 13-inch *VV1320W*, pictured here, has 181-channel compatibility, a unified remote control, on-screen displays for timer recording and picture adjustments, and a sleep timer. The VCR portion offers a real-time counter, double-speed playback, high-speed picture search, and end-of-recording search. *Ideal for a parents who would rather not watch Barney tapes in the living room (they can put it in the nursery), someone who might enjoy watching the day's soaps on tape while cooking dinner, anyone who can't be bothered messing with a tangle of wires, any teenager, and any college student.* Price: $549.95.



Quasar TVCR

Home Watching

Portable TV's have their place (lots of places, that is), but most people would rather watch TV from the comfort of their sofas or recliners than on the go. *Zenith*

Be a computer programmer!

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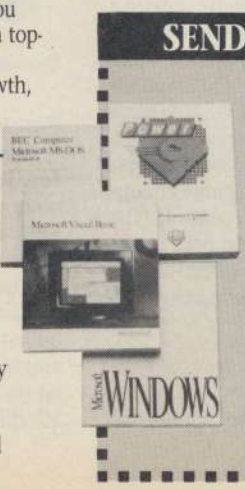

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Zenith 35-inch TV

Electronics Corporation offers a line of television sets designed for today's multipurpose family rooms—with smaller, contoured cabinets surrounding large screens, and for today's discriminating viewer—with Advanced Video Imaging (AVI) and MTS stereo with dbx noise reduction. The 35-inch-diagonal *SL3543RK* is an "electronic furniture" model with the television built into a contemporary, oak-color, cabinet with a pair of 15-watt speakers and room for a VCR and tapes. The AVI system includes enhancement circuitry for an improved contrast-to-brightness ratio with vivid colors, as well as a high-contrast, darker screen, all of which translates to reductions in "blooming" and distortion, crisply defined edges, and truer flesh tones. The *SL3543RK* comes with two remote controls: one full-featured and one "everyday" with only the most commonly used buttons. The cabinet sits on a swivel base, for easy viewing from all around the room. *Ideal for anyone who watches TV, particularly for family viewing*. Price: $2299.

Home is Where the Theater Is

If your family has followed the "cocooning" trend—electing to spend their leisure time in the warmth and comfort of home—home theater can make staying in more exciting than going out. The focal point of any home-theater system is the TV, and *Panasonic Company's PT-51-SF30* 51-inch rear-projection set provides a picture that fills the room, in an unobtrusive cabinet that's just 21¾-inches deep. The set offers a sharp picture with 750 lines of horizontal resolution, thanks to CRT projectors that provide better light on the corners of the picture, a dark-tinted screen, and "Artificial Intelligence Control," which continually uses digital oversampling to analyze and adjust the contrast in those areas that need it most. The TV's Active Dome Sound System provides simulated surround sound through a pair of two-way, rear-mounted speakers heard through ported openings on sides of the screen; a graphic equalizer and dbx noise reduction are built in. A center-channel input for Dolby Pro Logic allows the built-in speakers to be used as the center-channel speaker in a surround-sound setup. Special features include an icon-driven on-screen menu, dual tuners for viewing adjustable-size picture-in-picture without a second video source, favorite-channel memory scanning, and channel lock. *A big-ticket gift for the entire family!* Price: $3399.

Panasonic 51-inch rear-projection TV

SharpVision LCD projector

Looking at the Big Picture

(Skip this item unless your Christmas account has hit five figures, or Santa Claus is a close personal friend.) For upscale home-theater systems, a "dinky" 50- or 60-inch screen won't cut it. *Sharp Electronics Corporation* offers the *SharpVision XV-S80U* LCD projector, whose 200-inch image has 560 lines of horizontal resolution. The unit can be ceiling mounted or set on a table-top, and at just 32 pounds, it easily can be moved to other locations. A built-in speaker and amplifier facilitate portable use. The XV-S80U has a built-in line-doubled scanning system, reverse and inverse video (for front or rear projection), fuzzy-logic brightness control, and a backlit remote control. The power zoom/focus lens can be used to adjust the image size from 25- to 200-inches diagonal. *For the "discriminating vidiophile."* Price: $11,500.

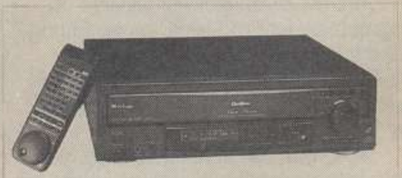
Box Office in a Box

Lots of people already own a good-sized TV and some speakers. To turn their existing equipment into a home theater, *Mitsubishi* offers the *HTS-100 Instant Home Theater* A/V receiver. Designed to be easy to install and operate, the unit offers Dolby Pro Logic Surround Sound that turns on automatically when the TV is switched on. The HTS-100 requires a simple, one-step installation, and doesn't disrupt the normal connections between the TV and VCR or laserdisc player, so even the least technically inclined family members will be able to use the system. *The way to go for technophobes who would like to get in on the home-theater experience*. Price: $599.

Mitsubishi Instant Home Theater

Digital Video

Once your family has a home-theater set up, they're sure to want to watch the best quality video possible, and that means laserdisc. *Quasar's LD700* has the feature we always look for in laserdisc players—autoreverse. It automatically plays both sides of a disc for continuous play (actually, an 11-second delay), without requiring the user to get up and flip the disc manually. The unit's four-times, eight-bit Digital field Memory is said to provide virtually noiseless stills, slow-motion, and search modes, and the jog/shuttle dials on both the front panel and the remote allow a variety of playback effects. The *LD700* also features a digital noise-cancellation system and a digital servo control that adjusts the disc's tilt/height, focus, and tracking. *A great addition to a home-theater system*. Price: $999.95.



Quasar laserdisc player

Picture Window

Video doesn't just mean TV. Camcorders have revolutionized the way we preserve our special moments, from births to weddings, from vacations to sporting evens. Now *Sharp Electronics Corporation* has revolutionized the way we use our camcorders. The *ViewCam* doesn't require the videographer to squint through a single lens. Instead, subjects can be viewed on a full-color LCD screen. The 8mm *VL-E30U*, with its 3-inch LCD viewing screen, is the most affordable ViewCam. Its variable-angle rotating system rotates 270 degrees to allow the camcorder to be held overhead, at lap level, or any way that feels comfortable to the user and the subject. The camcorder also features an 8 × power zoom lens and 16:9 wide-screen recording capability. *Ideal for new parents and anyone who would like instant playback of videos taken on vacations or at sporting events. Families with small children could keep them quiet on car trips by recording their favorite TV shows on 8mm tapes and playing them back on the ViewCam.* Price: $1199.95.

Sharp ViewCam

Turn, Turn, Turn

Ideally, a television should be located directly in front of the sofa from which viewers will be watching it. In reality, however, furniture arrangements often don't take prime viewing angles into account. *TurnVision*, from *SefidCo Control Systems*, is a motorized TV turntable that swivels the TV up to 90 degrees from its straight forward position. Any standard TV remote control can be used to control the TurnVision. The device comes in sizes to fit televisions measuring from 13 to 35 inches. *A couch potato's delight!* Price: $199.

SefidCo TurnVision

Cable Tamer

If someone on your gift list *still* can't program a VCR—especially when confronted with a cable box and scrambled cable channels—there is a simple solution. *Fisher's FVH-4509* features VCR Plus+ programming with cable-box control. The VCR must be programmed once. After that initial setting, all that's required is to enter the PlusCode that is printed in many local papers and in *TV Guide*. The VCR then comes on at the right time, sets the cable box to the proper channel, records the program, and shuts down. The system is virtually foolproof, even for someone who has yet to record a program. *Perfect for the technologically confused.* Price: $329.95.

Fisher VCR with VCR Plus+

MULTIMEDIA CHRISTMAS GIFTS

If your household prefers to take a more active role in their entertainment—or maybe even spend some of their leisure time learning!—consider giving the family the gift of multimedia. Today's multimedia machines offer interactive game-playing, learning, and entertainment along with digital audio, Photo CD, and, just in time for Christmas, full-motion video. There are programs to appeal to everyone, including sports and fitness clinics, music- and art-appreciation courses, role-playing and simulation games, and multimedia encyclopedias, cookbooks, first-aid, and gardening guides. Let's take a look at two of the hottest systems this season.

FMV on CD-I

CD-I, or *Compact Disc-Interactive* players have seen slow but steady sales since the format's introduction last year. We wouldn't be surprised if this holiday season is the one that gets sales into high gear, now that *Philips* is introducing a full-motion video (FMV) cartridge that gives CD-I users the ability to watch movies and other videos. The cartridge, which is compatible with all of the more than 100,000 CD-I players that have already been sold, takes advantage of the MPEG-1 (Moving Pictures Expert Group) digital-video standard. It is said to provide video quality equal to VHS tapes and CD-quality audio. Paramount Pictures has promised to deliver more than 50 titles initially. *A must-have item for anyone who already owns a CD-I machine (and a good reason to buy CD-I for the family).* Price: $250.

PHILIPS
Digital Audio/Video Module

Philips FMV cartridge for CD-I

3Get Real!

Also hitting the shelves just in time for the holidays is *Panasonic's R.E.A.L. 3DO Multiplayer*. The device (which was a hit at the last two Consumer Electronic Shows even though no real, fully functional hardware was yet available or on display) is likely to be one of the most talked-about electronic devices this season. It promises breakthrough performance in electronic gaming machines and video realism that hasn't been feasible before. Although 3DO is primarily a game machine, educational titles are also available, so you needn't feel too guilty buying one for your kids (or yourself). *Perfect for any videogame addict looking for the next great game platform.* Price: $699.95.

INTERACTIVE COMPUTING

Multimedia is not just for the family room. Computers are an ideal medium for interactive fun and education. If someone on your list is ready for a computer upgrade, put a multimedia PC (MPC) under his or her tree. For those who already have the requisite hardware, there are hundreds of interactive programs on the market. Some of them are sure to appeal to the computer users, from preschoolers to adults, on your Christmas list.

Sound Monitor

In the not-too-distant future, a sure test of someone's age will be whether he or she remembers a time when the only sound computers made was an occasional beep. As software continues to make sound an integral part of computing, we're sure to see more monitors like *Proton's PM1561*. The 15-inch multimedia PC monitor features built-in, side-mounted stereo speakers and a built-in amplifier. The non-interlaced monitor with a 0.28mm dot pitch can provide resolution up to 1280 × 1024 pixels. A headphone jack, which automatically mutes the main speakers when in use, is provided for private computing. *A great upgrade for the discriminating MPC user.* Price: $799.

Proton MPC monitor

NAMES AND ADDRESSES

The 3DO Co.
1820 Gateway Drive
SanMateo, CA 94404
CIRCLE 50 ON FREE INFORMATION CARD

Aiwa America, Inc.
800 Corporate Drive
Mahwah, NJ 07430
CIRCLE 51 ON FREE INFORMATION CARD

AudioSource
1327 North Carolan Ave
Burlingame, CA 94010
CIRCLE 52 ON FREE INFORMATION CARD

Best Data Products
9304 Deering Ave.
Chatsworth, CA 91311
CIRCLE 53 ON FREE INFORMATION CARD

Bose Corporation
The Mountain
Framingham, MA 01701
CIRCLE 54 ON FREE INFORMATION CARD

Canon USA, Inc.
One Canon Plaza
Lake Success, NY 11042
CIRCLE 55 ON FREE INFORMATION CARD

Cobra Electronics Group
6500 West Cortland Street
Chicago, IL 60635
CIRCLE 56 ON FREE INFORMATION CARD

Compton's NewMedia
2320 Camino Vida Roble
Carlsbad, CA 92009
CIRCLE 57 ON FREE INFORMATION CARD

Computer Directions
2712 West Shaw Ave, #234
Fresno, CA 93711
CIRCLE 58 ON FREE INFORMATION CARD

Discwasher, Inc
46-23 Crane Street
Long Island City, NY 11101
CIRCLE 59 ON FREE INFORMATION CARD

Edmark
6727 185th Ave. NE
Redmond, WA 98073
CIRCLE 60 ON FREE INFORMATION CARD

Esoteric Sound
4813 Wallbank Ave.
Downers Grove, IL 60515
CIRCLE 61 ON FREE INFORMATION CARD

Fisher
21350 Lassen St.
Chatsworth, CA 91311
CIRCLE 62 ON FREE INFORMATION CARD

Ford Motor Company
P.O.Box 1509-A
Dearborn, MI 48121
CIRCLE 63 ON FREE INFORMATION CARD

Fox Electronics and Technology, Inc.
2021 Midwest Rd.
Oak Brook, IL 60521
CIRCLE 64 ON FREE INFORMATION CARD

Franklin Electronic Publishers, Inc.
122 Burns Rd
Mt. Holly, NJ 08060
CIRCLE 65 ON FREE INFORMATION CARD

Gates Energy Products
P.O. Box 147116
Gainesville, FL 32614
CIRCLE 66 ON FREE INFORMATION CARD

Interactive Publishing
300 Airport Executive Park
Spring Valley, NY 10977
CIRCLE 67 ON FREE INFORMATION CARD

Koss Corp
4129 N. Port Washington Ave.
Milwaukee, WI 53212
CIRCLE 68 ON FREE INFORMATION CARD

Memtek Products
P.O. Box 901021
Fort Worth, TX 76101
CIRCLE 69 ON FREE INFORMATION CARD

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052
CIRCLE 70 ON FREE INFORMATION CARD

The PC Speaks Out

Of course, a new monitor is not needed to get better sound. For those who are satisfied with their present monitors, *Koss' HD/6* amplified computer speakers would be a better buy for many. The HD/6 can be powered from a 6-volt DC adapter that is supplied with them, or they can run on four "C" batteries. When no audio is present at their inputs, the speakers enter a sleep mode to conserve battery life. The speakers feature four-inch drivers and are magnetically shielded so that they can be placed next to a computer monitor without distorting the picture. *A terrific gift for anyone who is tired of using headphones to listen to a sound card.* Price: $99.95.

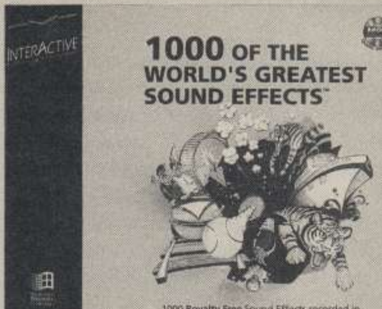
Koss amplified computer speakers

Human Interaction

Even avid game-playing computer users get bored with only their PC's for company (we hope!). But the *Game Modem* seems a sure cure for any creeping ennui. The hardware/software bundle consists of a 2400-baud modem form *Best Data Products* and software from *The Sierra Network*, or *TSN*, an on-line interactive entertainment service. Three hours of access to the interactive network are included with the package, as is a $30 credit toward TSN membership and usage. Members of the network can communicate with other members and play a variety of games in real time, against real people. *Perfect for any PC user who likes people and likes to play games.* Price: $49.

Sounds Galore

If you know someone with a new sound card (perhaps someone who will be getting a sound card for Christmas), consider giving him *Interactive Publishing's 1000 of the World's Greatest Sound Effects*. The disc, which runs on a multimedia PC (MPC), has an Attach utility that allows any sound effect to be associated with any Windows system event. An error message, for instance, could great the user with a .38-caliber pistol shot. Each effect is recorded in both 8-bit and 16-bit formats. A supplied wave-editor utility lets users edit and add special effects to the sound, or


INTERACTIVE
1000 OF THE WORLD'S GREATEST SOUND EFFECTS™
1000 Royalty Free Sound Effects recorded in both 8 bit and hi-fidelity 16 bit formats
Professional Wave Editor lets you customize and create your own sound effects
Easy to use Sound Finder™ and Attach Utility
PC
CD-ROM
Sound effects on CD-ROM

NAMES AND ADDRESSES

Mitsubishi Electronics America
5757 Plaza Drive
Cypress, CA 90630
CIRCLE 71 ON FREE INFORMATION CARD

Panasonic Company
One Panasonic Way
Secaucus, NJ 07094
CIRCLE 72 ON FREE INFORMATION CARD

Philips Consumer Electronics Co.
One Philips Drive
Knoxville, TN 37914
CIRCLE 73 ON FREE INFORMATION CARD

Proton Corporation
16826 Edwards Road
Cerritos, CA 90701
CIRCLE 74 ON FREE INFORMATION CARD

Quasar Company
1707 N. Randall Road
Elgin, IL 60123
CIRCLE 75 ON FREE INFORMATION CARD

Radio Shack
700 One Tandy Center
Fort Worth, TX 76102
CIRCLE 76 ON FREE INFORMATION CARD

R.L. Drake Company
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Miamisburg, OH 45342
CIRCLE 77 ON FREE INFORMATION CARD

Sanyo Fisher USA Corp
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Chatsworth, CA 91311
CIRCLE 78 ON FREE INFORMATION CARD

Sefidco
2950 Somprosa St
La Costa, CA 92009
CIRCLE 79 ON FREE INFORMATION CARD

Sharp Electronics Corp.
Sharp Plaza
Mahwah, NH 07430
CIRCLE 80 ON FREE INFORMATION CARD

Software Marketing Corporation
9830 South 51st St
Building A-131
Phoenix AZ 85044
CIRCLE 81 ON FREE INFORMATION CARD

Sony Corp of America
Sony Drive
Park Ridge, NJ 07656
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Speaker-Sculpture
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New Rochelle, NY 10801
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Tandy
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TSN The Sierra Network
P.O. Box 1550
Oakhurst, CA 93644
CIRCLE 85 ON FREE INFORMATION CARD

World Library, Inc.
12914 Haster Street
Garden Grove, CA 92640
CIRCLE 180 ON FREE INFORMATION CARD

Yamaha Electronics Corp., USA
6660 Orangethorpe Ave.
Buena Park, CA 90620
CIRCLE 179 ON FREE INFORMATION CARD

Yes! Entertainment
3875 Hopyard Road
Pleasanton, CA 94558
CIRCLE 178 ON FREE INFORMATION CARD

Zenith Electronics Corporation
1000 Milwaukee Ave
Glenview, IL 60025
CIRCLE 177 ON FREE INFORMATION CARD

combine sounds for a user-created custom-effects library. *Fun for any MPC sound-card user.* Price: $49.95.

The Compleat Beatles

Beatlemania for the 90's

Another way to put a multimedia PC through its paces is with *Compton's New-Media's The Compleat Beatles*. The CD-ROM features the entire "rockumentary" *The Compleat Beatles*, as well as Virgin Books' 700-page *The Ultimate Beatles Encyclopedia*. Lots of additional photographs are also on the disc. *A great gift for anyone who grew up listening to everything from "Meet the Beatles" to "Let it Be."* Price: $99.95.

Exercise Program

Those same fans of the Fab Four, having hit the big four-oh, can probably no longer fit into their hip-hugger bell-bottoms. Exercise might help, but, let's face it, it's hard to stay motivated without a personal trainer. *Fitness Partner*, a CD-ROM product from *Computer Directions* turns a PC into a personal trainer. The disc, which will run on MPC's or VIS machines, accepts information about the gender, age, and fitness level of the user and customizes the program to meet the user's weight-loss or muscle-toning goals. Users can also develop their own routines, choosing from the 75 video exercises included on the disc. The speed and number of repetitions can be saved as a kind of personal exercise video. *For the fitness freak or the perpetual dieter who is easily bored by routine—but make sure the recipient isn't so weight-conscious that he or she might take it the wrong way!* Price: $69.95.

Fitness Partner

They're Baaack!

The biggest hit of 1993 is something that has been extinct for millions of years—the dinosaur. With the toy tie-ins for Barney and Jurrassic Park, if there are any kids on your list, you're sure to be buying plenty of dino-related goodies this year. Kids of all ages can play with *Microsoft Dinosaurs*, which lets MPC users take an interactive foray into the world of dinosaurs—without the dangers of a trip to Jurassic Park! Users can see what the dinosaurs looked like, and hear how they might have sounded. The sights and sounds of the prehistoric world are brought to life in this multimedia tour, which includes more than 1000 color illustrations and photos, and video from the PBS series "The Dinosaurs!". Nearly 200 articles about dino-

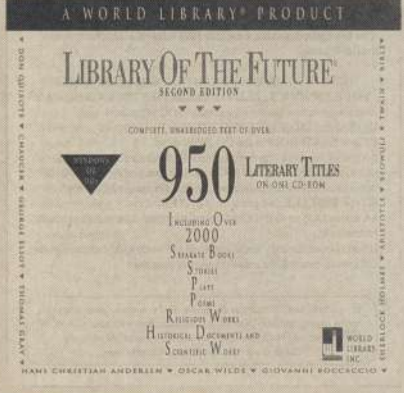
Microsoft DINOSAURS
An Interactive Journey into the World of Dinosaurs

Microsoft Dinosaurs

saurs and their world are contained on the disc. Images of dinosaurs can be used to create Windows wallpaper, or they can roam your screen during periods of inactivity with the included screen savers. *For anyone who is fascinated by dinosaurs.* Price: $79.95.

Books on Disc

We doubt that printed books will be completely replaced by electronic versions in our lifetime, but our love for the printed word doesn't preclude our appreciation for the millions of printed words that can be squeezed onto a single CD-ROM. *World Library's Library of the Future, Second Edition*, for instance, contains the complete text of more than 2000 novels, essays, poems, short stories, plays, and other literary works. They are compiled from a total of 950 full works of literature, history, religion, science, philosophy, and children's classics. A random sampling of titles: the King James Bible, the U.S. Constitution and Declaration of Independence, the complete works of Shakespeare, all of the Sherlock Holmes books, and *Aesop's Fables*. The program allows users to search for words or phrases throughout a single text, a single author's works, by time period or country, or any combination of the above. Titles can be downloaded to floppy so that they can be read on a laptop or PC that is not equipped with a CD-ROM drive. The software runs under Windows or MS-DOS. *A great gift for book-lovers, students, and writers!* Price: $299.


A WORLD LIBRARY® PRODUCT
LIBRARY OF THE FUTURE
SECOND EDITION
950 LITERARY TITLES
ON ONE CD-ROM
INCLUDING OVER 2000 SEPARATE BOOKS
STORIES
PLAYS
POEMS
RELIGIOUS WORKS
HISTORICAL DOCUMENTS AND SCIENTIFIC WORKS
HANS CHRISTIAN ANDERSEN • OSCAR WILDE • GIOVANNI BOCCACCIO

Library of the Future

SOFTWARE SUGGESTIONS

We have always considered books (the ones on paper, that is) to make excellent presents. There is such a tremendous selection that it is easy to match the age, interests, hobbies, and personalities of just about everyone on our gift list with an appropriate title. These days, the same can be said for software titles, and it seems that almost everyone we know (with the possible exception of a grandparent or two) has become computer literate to some degree. Try to match the folks on your list to some of the programs below.

Baby Talk

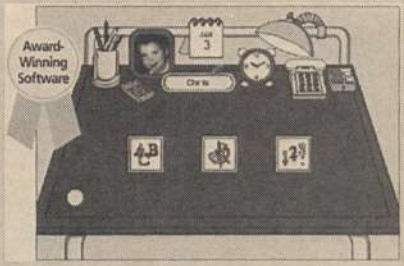
When it comes to their first baby, most couples (or single mothers) are desperate for information. They have questions on everything from nutrition to nursing, natural childbirth to pediatrician visits. Past generations thumbed through Dr. Spock's books. In the electronic age, expectant parents can turn on their computers and scan through *B.A.B.Y—Birth and Baby Years*, from *Software Marketing Corporation*. The computerized guide leads them from pre-pregnancy to birth and beyond, allowing them to input their own data about genetics and conception conditions (it includes a fertility chart), right on through to feeding schedules and doctors appointments. The program provides information about fetal development, boys and girl's names, medical tests, diet and exercise. Expectant parents can check in weekly during pregnancy to see the baby's development depicted and explained on screen. *For first-time expectant parents.* Price: $59.95.

B. A. B. Y.
BIRTH AND BABY YEARS
A Computerized Guide

B.A.B.Y.

Never too Young

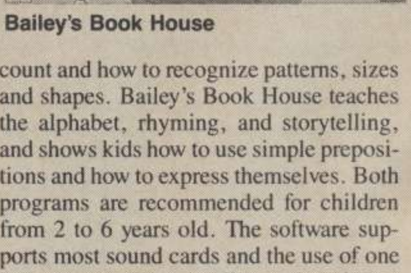
When that baby becomes a toddler, computer-using parents all have the same complaint: They just can't keep the little tykes away from the PC! Most parents want to encourage their children to become familiar with computers, but they're hesitant to put a child in charge of a computer that contains the household budget, banking records and other important information. A gift that will keep both kids and their parents happy is *KidDesk* from *Edmark*. KidDesk allows kids to launch their own programs using easy to understand icons, but prohibits them from accessing their parents' files. Recommended for children aged 3 to 10, the program contains such desktop items as a customizable monthly calendar, a talking clock, and a calculator. *A must-have for households that include both kids and computers!* Price: $39.95.



KidDesk

Pre-School Programs

Two programs that children might want to launch with KidDesk are *Millie's Math House* and *Bailey's Book House* (pictured), both from *Edmark*. Millie's Math House endeavors to teach children how to count and how to recognize patterns, sizes and shapes. Bailey's Book House teaches the alphabet, rhyming, and storytelling, and shows kids how to use simple prepositions and how to express themselves. Both programs are recommended for children from 2 to 6 years old. The software supports most sound cards and the use of one is recommended as it will greatly enhance both learning and fun. *A great gift for curious kids.* Price: $49.95 each.



Bailey's Book House

THE WHOLE WORLD IN YOUR HAND

Even though computers have gotten small enough to keep in a briefcase, there are times when they must be left behind. Even in those cases, however, it's still possible to carry along a source of information, communications, and organization in a pocket or purse. If there are people on your list who hate to be uninformed or out-of-touch, there are several handheld devices that they'd love to find gift-wrapped. Those include portable book systems that "read" matchbook-sized electronic books, and the new category of personal digital assistants, or PDA's, with advanced handwriting-recognition systems that translate pen-written notes into digital text. PDA's can go well beyond note-taking, however, with the ability to send and receive faxes and E-mail and download data to a computer.

Pocket-Sized Library

Living in the information age, we often need to have specialized information at our fingertips, even when we're not in our offices or homes. *Franklin Electronic Publishers* places a library of data in a pocket or purse with the *DBS-2* Digital Book System. The DBS-2 measures just 3 × 5 × ½ inches and weighs 4.6 ounces. Two compartments on the back of the unit accept tiny, interchangeable ROM cards known as Digital Books. Using data-compression technology, each Digital Book can store up to the equivalent of 20 printed Bibles. A wide variety of titles are available (and make great gifts for those who already own a DBS, priced from $29 to $129), on subjects including health, cooking, religion, foreign languages, entertainment, sports, medicine, and nutrition. There are also game cards and reference cards. Stockbrokers, analysts, and investors will love *The Tradeline pocket stock guide (pictured), and doctors will appreciate The Physician's Desk Reference* and *The Medical Letter Handbook of Adverse Drug Interactions*—particularly because it's possible to instantly cross-reference between books. The DBS-2 includes sound, allowing users to hear speech and sounds from reference, educational, and entertainment cards. It also provides serial-port communications with a PC. *Makes a good gift for students, professionals, cooks, gardeners, game-players, movie and sports fans, doctors, frequent travelers . . . .* Price: $129.

Franklin Digital Book System

Sony Data Discman

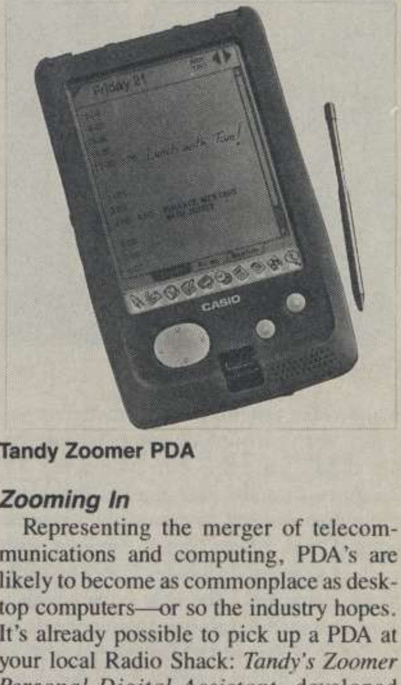
Data to Go

Sony's answer to the need for portable reference material is the *Data Discman Model DD-20*. The electronic book player puts libraries of information in the palm of your hand. It plays 3-inch optical discs called "electronic books." Each stores any combination of more than 100,000 pages of text, 32,000 graphics, or six hours of audio. More than 100 titles are available, ranging from *Monarch Notes* to literary masterpieces. The Data Discman weighs about a pound and features built-in speakers. Buyers can opt for a package that includes either *Passport World Traveler Translator*, an eight-language audio program, or *Grolier's Electronic Encyclopedia. Another winner for students and travelers*. Price: $349.

Sharp Expert Pad

Consult an Expert

Busy people tend to spend a lot of time—at home, at work, and on the road—jotting down notes, making lists, scheduling and rescheduling appointments, sending faxes and E-mail messages—and then struggling to keep all that data organized. *Sharp's PI-7000 Expert Pad*, the first licensed Personal Digital Assistant (PDA) based on Apple Computer's Newton Intelligence, lets the user do all that, and more. The Expert Pad recognizes both graphics and handwriting (script and print), and actually learns to recognize its owner's unique scrawl. A stylus is used to write the information directly on the front panel LCD screen. Notes, addresses, appointments, to-do lists can be filed away in specific categories for easy recall later on; a search function makes it easy to find a specific document or name. The unit can transfer data to another Expert Pad via wireless infrared transmission. Software/hardware packages to link the PDA to an Apple computer or an IBM-compatible PC are available as options, as is a fax/modem attachment. It's also possible to link the unit to a Sharp Wizard or to a printer. The Expert Pad accepts PCMCIA memory cards, allowing the user to plug in preprogrammed applications, such as travel guides or a Motorola pager card. Smaller than a VHS videocassette, the PI-7000 is easy to carry on business trips, or just around town. *Ideal for executives and anyone who travels frequently but would rather not lug around a laptop.* Price: $899.



Tandy Zoomer PDA

Zooming In

Representing the merger of telecommunications and computing, PDA's are likely to become as commonplace as desktop computers—or so the industry hopes. It's already possible to pick up a PDA at your local Radio Shack: *Tandy's Zoomer Personal Digital Assistant*, developed jointly with *Casio*. The Zoomer fits in a coat pocket or purse, and runs for up to 100 hours on three standard "AA" batteries. Information is input in block print, and the device translates it to type; or a pop-up on-screen keyboard can be used. A PCMCIA slot allows the addition of more memory or such applications as a nationwide paging service and a fax/modem. When you're finished using the Zoomer to organize your life, manage your money with built-in Pocket Quicken (a portable financial organizer program), and look up information in the dictionary, spell-checker, thesaurus, or language translator, you can use it to relax, with the built-in games of strategy and chance. *Another great gift idea for anyone who needs help getting and staying organized, or who needs to keep in touch while traveling*. Price: $699.

KID STUFF

Kids and electronics go together as well as peanut butter and jelly—just look how they take to TV, VCR, and Nintendo! We're not suggesting that you go out and buy your children their own video components, however. There are plenty of other electronic goodies to interest the youngest people on your shopping list.

Talking Teddy

Children can spend hours watching the same videos time after time, with zombie-like stares. If you can't get them away from their favorite tapes, there's still a way to make video watching an interactive experience that encourages some activity on the child's part. *Yes! Entertainment's TV Teddy* is a teddy bear that's filled with more than stuffing—he contains a remote control that allows him to interact with each of a dozen videotapes featuring well-loved characters. The bear comes with a special transmission box that connects to the VCR. When one of the special tapes is played, TV Teddy interacts with the show, talking, singing, laughing, and asking questions in direct response to what is occurring on screen. Throughout the show, he encourages children to follow along with programs that teach the alphabet and numbers. *Aimed at TV lovers aged 3–8*. Price; About $65, including a Berenstain Bears videotape; additional tapes cost under $12.95.

TV Teddy
NOT-SO-BURIED TREASURE

TV Teddy

My First Music

For young music lovers, the *My First Sony CFM-2050* stereo radio/cassette recorder has a built in microphone that lets kids sing along with their favorite songs, or even make their own recordings. The boldly-colored unit features bright graphics on large button controls, to make it easy for non-readers to use. The My First Sony is ruggedly constructed of high-impact plastic that's light enough for young children to carry around yet durable enough to withstand abuse. *Great for kids who have a collection of "read-along" book/cassette packages, and for budding singers!*. Price: $89.

SONY
my first Sony

My First Sony

Pop-Up Playsets

Kids have always loved pop-up books, and now there's even more to love. *Yes! Entertainment's Pop-Up Sound-Up Playsets* combine sound-effects with pop-up scenes and colorful molded characters to create a dynamic play environment. Each playset pops up to reveal a captivating setting—a Victorian doll house, a police/fire station, a dinosaur landscape, or the Berenstain Bear Tree House, for instance—and folds back down into an easy-to-store book. Each comes with four play figures, which are featured in the story, and ten electronic sound effects, which enhance the action. The Playsets are designed to encourage children to make up their own stories, as well. *Terrific for kids who have just learned to read*. Price: Under $20.

Pop-Up Playset

Games People Play

Kids of all ages will enjoy *Franklin Electronics' WG-15 Word Games*. The pocket-sized device includes 10 word games: Hangman, Flashcards, Anagrams, Jumble, Word Train, Spelling Bee, Word Blaster, Word Builder, Deduction, and Memory Challenge. The games are designed to challenge and entertain while improving spelling and memory skills. Five different levels of play allow the user to make the games more difficult as his skills improve. *A good gift for anyone who loves word games*. Price: $29.95.

Franklin
Word Blaster
WORD GAMES

Franklin Word Games

PHONE HOME

Any teenager would be sure to appreciate their own telephone—but make sure to clear it with their parents before your buy and wrap it! You might also consider giving someone a cordless phone for chatting while puttering in the kitchen or workshop, or a combination clock/radio/telephone for bedside convenience.

Bedside Communications Center

Nightstands tend to be real clutter-collectors, crowded with books and eyeglasses, a lamp, a clock/radio, a phone, a water glass, and maybe a box of tissues. *Cobra* helps clear some of the clutter with the *Model CP-714*, a ten-channel cordless phone with an AM/FM clock radio built into the recharging base. The upright Intenna handset has an internal antenna (hence, "Intenna"), which allows the unit to be placed beneath a lamp, an arrangement not possible with traditional cordless phones with telescoping antennas. For

Cobra
INTENNA

Cobra Intenna clock radio

late-night phone calls, the backlit dial pad automatically illuminates with every incoming call. *A handy item for anyone in tight living quarters—apartment and dorm dwellers, in particular.* Price: $139.95.

STOCKING STUFFERS

One nice thing about all this electronic gear—from the gift-giver's point of view, at least—is that there is a multitude of accessories for each item. Even if you're shopping for the person who has everything, he or she probably could use a camcorder case or CD holder. Don't forget the perfect stocking stuffer—the batteries needed to power all those neat electronic gifts!

Charge!

Are there people on your gift list who frequently use a personal CD player, a personal stereo, a Game Boy, remote-controlled cars, a universal remote, a talking Barney doll, a camcorder, a CD boom box, a cordless or cellular phone, or an electronic keyboard? Of course there are! Those devices are the top ten users of "AA" batteries, so you might consider putting the *Millennium Charge Man* from *Gates Energy Products* (shown on page 5) in their Christmas stockings. The Charge Man comes with a charger and two "AA" batteries. The portable unit is small enough to tuck in a briefcase, backpack, or purse, and charges two "AA" batteries in three hours. The inexpensive charging kit can save lots of money in replacement batteries. *Ideal for just about anyone!* Price: $10.

Music to your Ears

Personal stereos and personal CD players abound—they're seen on jogging tracks, at the beach, in the park, at work, in homes, and on city streets. *Memorex* makes headphones that can go anywhere you take your personal stereo. They include the lightweight, in-ear *WeatherPhones*, designed for outdoor activities, and the *SL88V Stereo Earphones*, which feature in-line volume control and comfortable, non-slip rims. The *DLX 200 Digital Studio Quality* headphones have swivel ear cups for comfort; an adjustable, locking headband; and a single-side, single-entry cord for maximum mobility. *For all the personal-stereo users on your list.* Prices: $7.99 to $29.99.

MEMOREX
MEMOREX
MEMOREX
MEMOREX
MEMOREX

Memorex headphones

Keep it Clean

To keep any CD player—whether portable, a home unit, or a CD-ROM drive—and audio system working at their peak performance levels, *AudioSource's LLC-3* three-in-one utility disc cleans and tests audio systems, and provides music. The kit combines a laser-lens cleaner with test material for any audio system, including those with sophisticated Dolby Pro Logic surround configurations. The test disc helps the user balance a surround-sound system and assure proper speaker polarity. The disc also contains a set of test tones designed to provide an objective way to evaluate and adjust a stereo system. The cleaning system is completely automatic; the LLC-3 contains digitally encoded instructions to do all the work. As a bonus, the three-in-one system contains five music tracks representing a mix of digital recordings. *A great gift for serious music listeners.* Price: $29.95.

AudioSource
LLC3
LLC3

AudioSource utility disc

CD Bubble Bath

Taking a slightly different approach, *Discwasher* offers the *CD Hydrobath* for cleaning the discs themselves. With the unique, non-contact system, nothing touches the CD's except the CD6+ cleaning fluid, which contains both wetting and drying agents as well as an emulsifier. The disc is placed on a spindle inside the compact, self-contained housing. Touching the start button causes the disc to spin while a stream of cleaning fluid is pumped against the playing surface, creating a vigorous foaming action. The entire cleaning process takes less than one minute. Up to 100 discs can be cleaned with two ounces of fluid; a six-ounce bottle is included, along with the battery-powered housing. *A good gift for CD collectors.* Price: $59.95

For Computer CDs
CD HydroBath
Non-Contact Cleaning System
discwasher

Discwasher CD Hydrobath

Easy Touch

You probably know plenty of folks whose living rooms are being overrun by remote controls. There's one each for the TV, the VCR, the CD changer, the stereo, and the cable box. Perhaps there's even one for a Photo CD player, or a laserdisc player. *Fox Electronics' TouchScreen Fox 800* can replace as many as eight of those separate remotes with one universal unit. Unlike many universal remotes, which are jam-packed with tiny buttons, the Fox 800 has only ten buttons. The rest of its more than 200 controls are imprinted on a touch-sensitive LCD "command window." A light touch activates any command. Each touch is confirmed by audible feedback. There are eight different displays that change automatically for each component. Each has its own dedicated function-key icons as well as customizable ones. The Fox 800 is preprogrammed to operate almost every make of audio and video components once the correct codes have been entered. The device simplifies VCR timer programming; the user is prompted to enter the program's time, date, and channel, and the Fox 800 sends infrared signals to the VCR to start and end recording. The display is backlit for easy viewing in darkened rooms. *A terrific clutter buster!* Price: $99.95.

Fox 800 TouchScreen remote control

HAPPY HOLIDAYS!

From all of us here at **Gizmo**, a safe and happy holiday season to you and yours! ■

A Hands-on Electronics REPORT

ELENCO ELECTRONICS PT-223K TELEPHONE KIT

TELEPHONE KIT
MODEL PT-223K
Assembly and Manual
ELENCO ELECTRONICS,
Electronics, Inc. REV-A

CIRCLE 119 ON FREE INFORMATION CARD

Let your fingers do the building with the Elenco Electronics PT-223K Telephone Kit.

Telephones have become as commonplace as anything else these days. We simply take them for granted, yet would be lost without them. While silicon technology has provided us with some pretty amazing telephones, such as cellular units that fit in a shirt pocket, most phones aren't noteworthy. However, if you build one yourself, that's another story—people are always curious about home-made electronics, especially if you could have bought the item already built. Besides, hobbyists are a special breed that often prefer putting something together to buying it assembled. Well, the PT-223K Telephone Kit from Elenco Electronics Inc. (150 W. Carpenter Ave., Wheeling, IL 60090; Tel. 708-541-3800) is intended for just such people.

The PT-223K includes everything you need to build a telephone, including solder and the telephone's case, which is clear so every time you make a call you can see the fine work you did. While the PT-223K has a keypad-type dialer, it can only be used for pulsed dialing and can't be used for any touch-tone operated services. Four neon lamps inside the phone flash whenever it rings. Additional features include a mute button and a ringer switch.

The kit also includes items you'll need to install the phone. For example, although you can hang up the phone simply by placing it on a flat surface, a clear wall-mounting bracket that matches the phone is also included. Since there's a modular plug on the end of the phone cord, the kit also includes a modular phone jack in case you don't already have one—a nice touch. Not only does building the PT-223K give you something fun to do on a rainy day, it can also teach you a great deal about how telephones work. That's because the manual included with the PT-223K tells you both how to put the unit together and what the parts do. Even if you're not interested in how phones work, but are just in the market for a new one, then the kit (which only costs $15.95) represents a great value nonetheless.

The Kit. What would a kit be without the instruction manual that comes with it? Just a bunch of parts, of course! A good manual is what binds the parts together into a "project," so the manual either makes or breaks a kit. In this respect, the PT-223K's manual is a winner. It goes to great lengths to explain how telephones work, how to put the phone together, how to test the different sections of circuitry, and how to install your new phone. The manual is written in such a way as to cater to the classroom environment, in that each section of the circuitry is explained, assembled, tested, and presumably inspected by an instructor one section at a time. There are even a few quizzes at the end. However, no typical reader of this magazine should have any trouble building this project without an instructor. (You can even cheat on the quizzes and no one will ever be the wiser!)

The builder is first introduced to the telephone and its features, and also FCC requirements regarding terminal equipment. Next is a general description of the telephone system and how it works, beginning with a local loop connected to the phone company's central office (or CO). Each major part of a basic telephone is explained including pulse and tone dialing, the hook switch, the transmitter, the receiver, and the ringer. A parts list follows, with descriptions of the parts and how to identify them by their markings.

Before the assembly steps, an entire page is devoted to soldering tips. The page is useful if you need it and can, of course, be easily passed by if you don't. Note that no special tools are required to build the telephone, although some useful tools are listed in the manual. Assembly starts off with the installation of the ringer components on the single-sided PC board. Next, that part of the circuit is tested using a 9-volt battery. All the remaining sections of the phone are assembled in a similar manner until the main board is finished. In all, one IC and a handful of other components are installed.

The keypad is basically a rubber-button matrix that mounts on another small PC board. The keypad assembly is then connected to the main board through a length of ribbon cable.

The best part of building the phone is the final assembly, in which the boards are installed inside the clear case. It's nice to build a kit that has a case with a nice finished look on the outside, as well as a view of the inside. The final thrill, of course, is calling a friend on a phone that you built yourself.

The Elenco PT-223K telephone kit offers low price, good looks, and usefulness, making it an excellent project, especially for the beginner. If you agree, or just want to know more about the kit, contact Elenco directly, or circle No. 119 on the Free Information Card. ■

ELECTRONICS CATALOG
COLEMAN

"I'm trying to figure out exactly what little Johnny wanted for Christmas."

CONSUMER
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New solid-state and digital TV sets, stereos, and videorecorders are tougher to repair than old-fashioned tube type sets and require special training for the service technician who works on them.

Only a few states have laws requiring competency tests for licensing technicians who repair consumer electronics, but fifteen years ago the International Society of Certified Electronic Technicians (CET) began its own certification program to qualify these technicians and those in industry. To carry the CET designation, technicians must have four years experience and pass a rigid examination on general electronics and a specific area of expertise such as audio or radio-TV.

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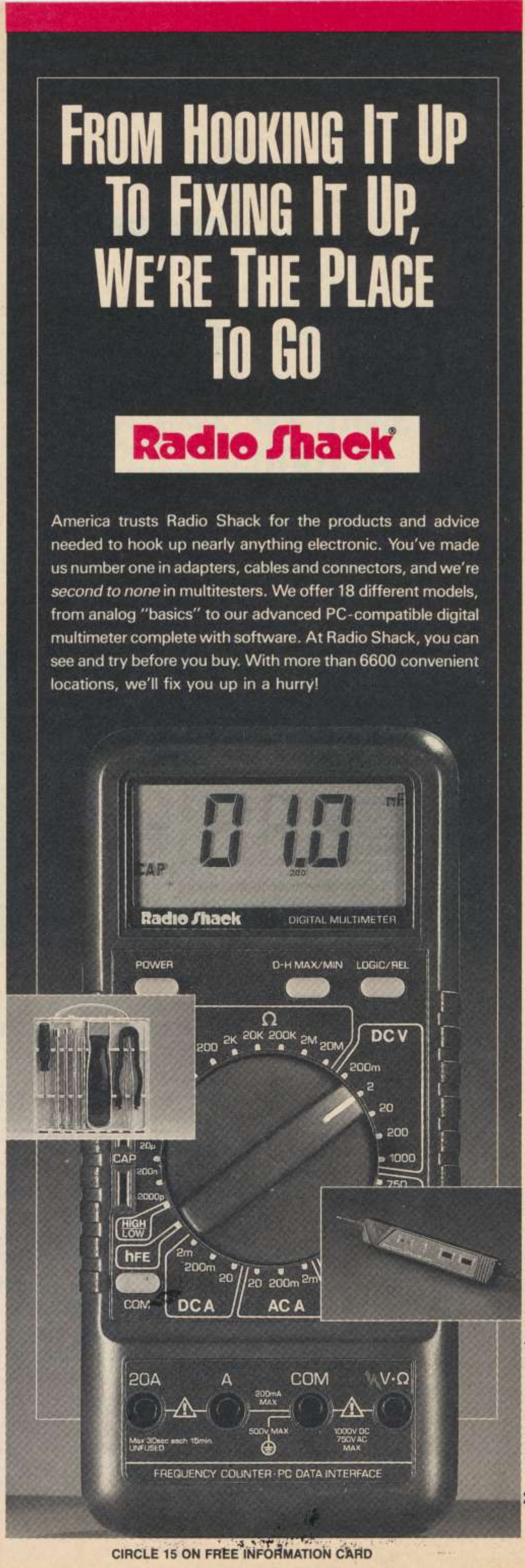
Modern electronic equipment such as digital TVs or stereos should be repaired by specially trained people.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PRODUCT TEST REPORTS

By Len Feldman

Sharp VL-HL100U ViewCam Camcorder

One look at Sharp's new and unusual Hi8 video camcorder is all it will take for you to exclaim, "Why didn't anyone think of this sooner?" Instead of squinting through the usual black-and-white or color electronic viewfinder while videotaping a scene, this remarkable camcorder has its own built-in 4-inch LCD monitor and large on-screen displays. You can see everything you record without having to fumble with button positions or controls. The anti-glare LCD screen makes viewing possible even outdoors in bright sunshine. You can hold the ViewCam (Sharp's name for this product) at a distance and still watch the action on the LCD monitor, making it ideal for eyeglass wearers and people who prefer to wear sunglasses while recording outdoors.

CIRCLE 120 ON FREE INFORMATION CARD

The Sharp VL-HL100U ViewCam Camcorder

The ViewCam's variable-angle rotating system enables both the monitor and lens sections to rotate freely. Using that feature, you can tilt up for a high-angle shot over people's heads, or tilt down for a low-angle shot, and still see the action you are recording. You can even swing the monitor around a full 180-degrees and record a picture of yourself while watching yourself on the monitor, or you can place the ViewCam down and record yourself from a distance using the supplied infrared remote control. The ViewCam's four-inch diagonal LCD screen allows the camcorder to act as a VCR for instant playback that's viewable by a group of people. For on-the-go entertainment, you can also use it to watch pre-recorded 8mm tapes. The ViewCam's "Digital Still Snapshot" function lets you to capture a five-second still image, complete with audio. You can also experiment with successive still-frames and the strobe function to create simple special effects.

Sharp has also incorporated Digital Electronic Image Stabilization in this camcorder. That feature compensates for slight hand movements or "picture bouncing" that often occurs when you walk along while using a hand-held camcorder. Other ViewCam features include an 8× power zoom, automatic exposure settings, full-range auto focus, hi-fi stereo recording, a flying erase head, high-speed electronic shutter, digital white balance, fade-in/fade-out, and a supplied infrared remote control.

Date-and-time "stamping" of your home videos is also possible; a small lithium battery maintains the correct day and time even when main power to the camcorder is turned off.

CONTROL LAYOUT

Viewed from the front, the record/stop button and a lock/standby switch are mounted beneath the zoom lens. A protective lens shutter closes over the lens when the unit is not in its "camera" mode. A two-element stereo microphone is mounted adjacent to the lens. The cassette compartment is also accessed from the front of the camcorder. A phone jack, a backlight-compensation switch, audio-and video-output jacks, a stabilizing stand, and a button for opening the cassette compartment are located along the right surface of the camcorder (as viewed from the front).

The rear of the unit is where you can find the picture- and volume-adjustment buttons, an index-search button, a full-auto/manual button, a record button (used when recording from an external source rather than from the camera section), and a fader button. The Still/Strobe and the Digital Image Stabilization (DIS) buttons are located to the right of the LCD screen. Five buttons located beneath the LCD screen serve dual purposes, depending upon the unit's mode. In the camera mode, those buttons are

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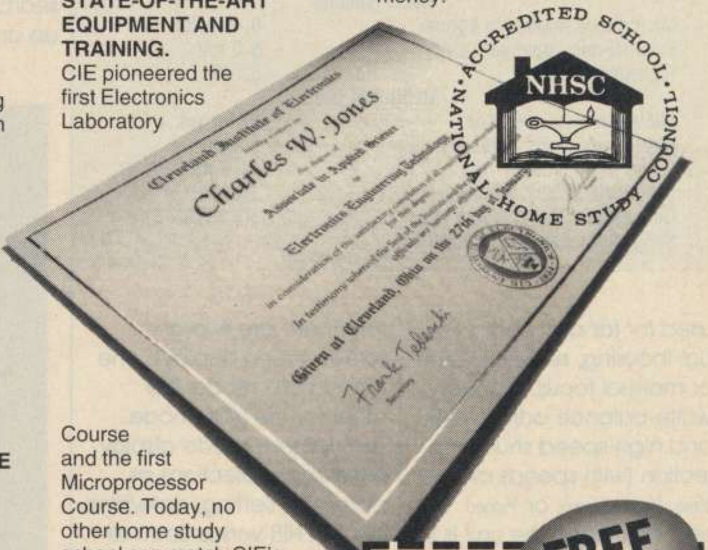

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TEST RESULTS—SHARP VL-HL100U CAMCORDER

Specification	PE Measured
Video Section	
Minimum illumination	5.6 lux
White balance	4 IRE
Color contamination	3 IRE
Resolution	
Camera	425 lines
Record/play video out	360 lines
Video Signal/Noise	
Chroma AM	
Camera	40.0 dB
Record/play cycle	39.9 dB
Luminance	
Camera	42.2 dB
Record/play cycle	41.4 dB
VCR Section	
Maximum usable luminance	18 foot-lamberts
Resolution	300 lines
Viewing angle	
Left/right	65/65 degrees
Top/bottom	40/20 degrees
Audio Section	
Microphone maximum output	0.45 volts
External-mic. input sensitivity	5.0 mV
Signal/noise ratio	52 dB
Additional Data	
Minimum focus distance	37 inches
Macro min. focus distance	¼ inch
Power requirements	14 watts
Weight (w/battery & cassette)	3⅛ lbs.
Dimensions (H × W × D, inches)	5⅞ × 7⅞ × 3 1/16
Suggested retail price: $2199.00	

used for far and near manual focusing, selecting auto or manual focus, manual white-balance adjustment, and high-speed shutter selection (with speeds of 1/100, 1/250, 1/1000, 1/4000, or 1/10000 second). When the unit is in the VCR mode (for tape playback), those same buttons are used for rewind/reverse search, play, fast-forward/forward-search, stop, and pause. You can choose to display the appropriate function for each of those buttons on the LCD screen. Wide and telephoto power-zoom buttons are located on the lens/camera section of the camcorder, while just to their left are the snap button (that records a five-second still picture) and an external microphone jack.

The top surface of the camcorder contains a menu button, a select/counter-memory button, and a set/counter-reset button. There are two on-screen menu displays: one for camera mode, the other for the VCR mode. The camera-mode display offers such selections as date/time setting, date/time display, Hi8 versus 8mm recording, remote on/off, and a confirmation of the current date and time. The menu display in the VCR mode allows you to select audio/video input or output (via the previously described A/V jacks), editing on/off, Hi8, and remote on/off. The three-position power switch found on the cylindrical surface of the zoom-lens body is used to select camera or VCR modes, or to turn camcorder power off entirely. The LCD screen, in addition to displaying a wide variety of the usual status indications (play, record, etc.), also provides the user with an assortment of warning indications such as a defective cassette, low battery voltage, "dew" (moisture), tape end, and "cassette not recordable"

The handheld infrared remote control supplied with this camcorder has been purposely made slim and small so that it can be hidden from view when you want to control the camcorder while you are recording yourself (along with others) in a given scene. Buttons on this tiny remote include the power-zoom buttons, the record start/stop button, play, pause/still, rewind/reverse search, fast forward/forward search, stop, and volume up and down buttons.

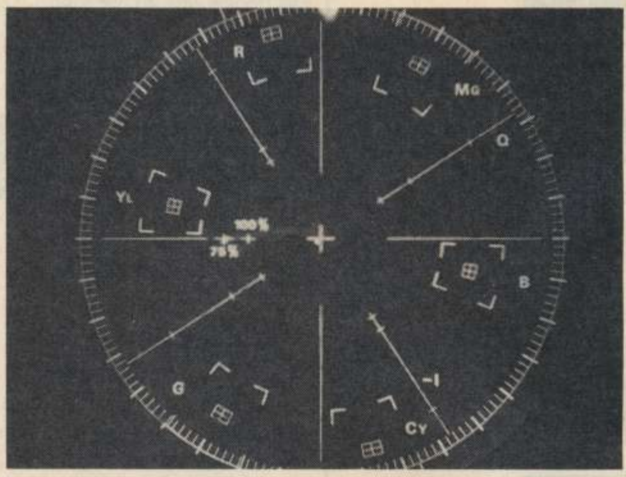

Fig. 1. Color-phase accuracy and saturation were measured using a red field and the results are shown in this vectorscope photograph.

TEST RESULTS

Because of the unusual nature of this camcorder, the Advanced Product Evaluation Lab (APEL), under the direction of Mr. Frank Barr, conducted more tests and measurements than would normally be made for a conventional unit equipped with the usual electronic viewfinder. All of APEL's measurements are summarized in the table appearing elsewhere in this report.

The minimum illumination required to allow a full-amplitude signal at the video output was 5.6 lux. Measuring white balance involves checking the amount of color bursts that appear on a neutral object when the balance control is set for optimum. In the case of this camcorder, that chrominance measured a minimal 4 IRE, which is a bit better than average for home camcorders.

Color contamination describes the degree to which color bursts appear on a fine black-and-white pattern; for this unit, the contamination was an insignificant 3 IRE. Color-phase accuracy and saturation was measured using a red field. Results are shown in the vectorscope photo of Fig. 1.

Thanks to the use of a CCD image sensor, the camcorder displayed virtually no streaking or lagging when quickly panned across a scene with variable lighting. Camera picture resolution in the Hi8 mode was an outstanding 425 lines. When measured through the entire record/play cycle, resolution decreased to 360 lines, but that is still considerably better than is available from

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DP20757	2	1	1,360	12.95
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DP49728	7417	.35	.29
DP50008	7420	.35	.29
DP50235	7432	.39	.35
DP50420	7447	.89	.79
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CIRCLE 156 ON FREE INFORMATION CARD

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Video signal-to-noise ratios measured directly from the camera video output were 40.0 dB for chroma (color) AM and 42.2 dB for luminance S/N ratio. When measured through the complete record/play cycle, the chroma AM S/N ratio was still a very acceptable 39.9 dB, while luminance S/N dropped to an equally acceptable 41.4 dB.

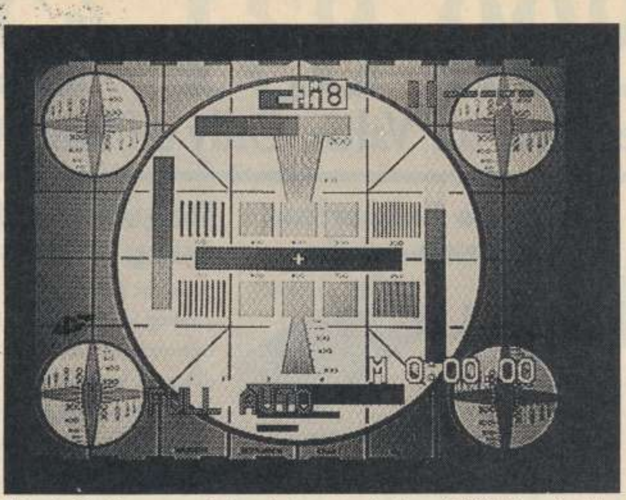

Fig. 2. Testing revealed a picture resolution of 300 lines for the built-in LCD monitor.

APEL made several measurements of the video section of this unusual product, treating the four-inch LCD screen much as they would a VCR. Maximum usable luminance from the LCD screen measured 18 foot-lamberts. Picture resolution measured 300 lines (See Fig. 2). One of the remarkable attributes of the LCD monitor was the fact that it could be viewed over a wide angle. In fact, the acceptable viewing angle extended a full 65 degrees to the left or right of the screen. As for the vertical viewing angle, it extended from 40 degrees (top) to 20 degrees (bottom); of course, if viewing angle in the vertical plane becomes a problem, you can always rotate the entire monitor section as needed.

The built-in microphone delivered a maximum audio-signal voltage of 0.45 volts, while the external-microphone-input sensitivity measured 5.0 millivolts. The audio signal-to-noise ratio measured an acceptable 52.0 dB. The minimum focus distance was 37 inches, while in the macro (close-up) mode it was possible to come as close as a ¼ inch from the subject while remaining in perfect focus.

HANDS-ON TESTS

Over the course of several weeks, we had an opportunity to use this novel camcorder for a variety of shooting assignments, both indoors and outdoors. Even though the 50-page owner's manual supplied with the product covers just about every feature and function of the camcorder, we were delighted to discover a couple of clever innova-

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tions that we may have missed in perusing the manual. One outstanding example occurs when you rotate the monitor section a full 180 degrees in order to "see yourself" in the picture as you shoot. Normally, having rotated the monitor screen through a full 180 degrees, you would expect the image on screen to be upside-down. Well, much to our surprise, Sharp even solved that problem; with the monitor facing the same direction as the lens, the on-screen image flipped over so that it was once again rightside-up!

Thanks to the glare-free design of the LCD screen (and its backlighting), there was no problem viewing the monitor even when we taped scenes in the bright outdoors. When subjects were overly backlit, the backlight-compensation feature restored a proper brightness and balance to the subjects being taped. The Digital Image Stabilization feature worked remarkably well, even when we bounced up and down in an exaggerated walking pattern. The editing of finished tapes by dubbing them onto another VCR is made remarkably simple with this camcorder and, of course, you don't have to connect to a TV set to do editing, since the LCD screen can serve as your editing monitor as you proceed with the job.

Admittedly, there are some minor drawbacks to this Sharp ViewCam. First, of course, is its rather steep suggested retail price of just under $2200.00. Secondly, because of the excellent brightness and size of the LCD screen, the unit consumes somewhat more power than would a conventional camcorder (around 14 watts). Also, although Sharp quotes the weight of the unit as under 2 pounds, with its fairly heavy battery module in place and with a cassette mounted in the cassette compartment, the weight increases to a bit over 3 pounds. For indoor taping, we preferred to use the AC adaptor (which also serves as a battery recharger).

We should mention another important feature that Sharp has incorporated into the AC adaptor: When recharging a battery, you can press a button labeled "refresh" which makes certain that the battery is first fully discharged before recharging begins. That not only prolongs the life of the battery, but insures that you will get the maximum recording time from it once it has been recharged.

All things considered, we believe that Sharp has broken new ground when it comes to camcorder design. We would not be surprised if other manufacturers follow suit and introduce their own versions of this design. Meanwhile, Sharp has an "exclusive" that's certainly worth its asking price and worth checking out if you are in the market for an up-to-the-minute, state-of-the-art camcorder that offers a real difference.

For more information on the VL-HL100U ViewCam camcorder, contact Sharp (Sharp Plaza, Mahwah, NJ 07430-2135) directly, or circle No. 120 on the Free Information Card. ■

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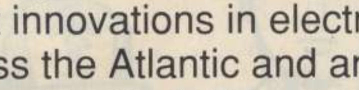
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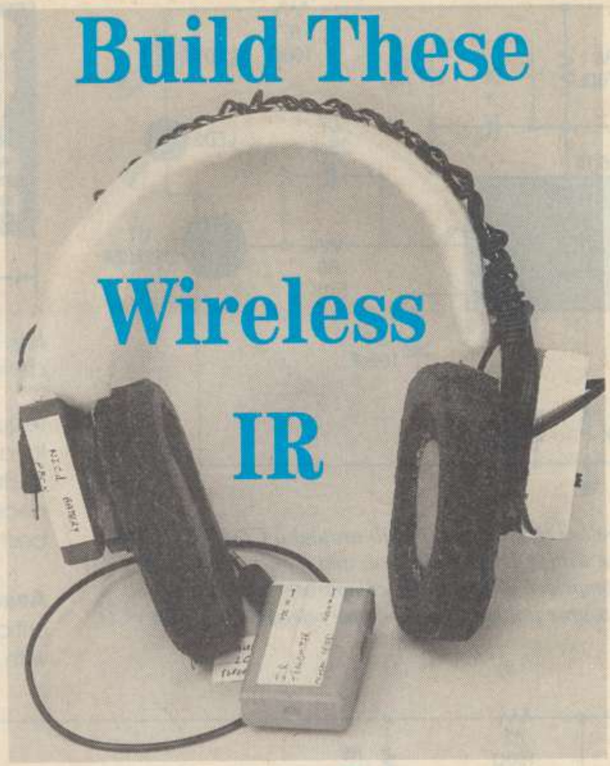
Build These Wireless IR Headphones



BY BRIAN MCKEAN

Listen to your favorite music unencumbered from a headphone cord with this easy-to-build transmitter/receiver combination

The age of wireless is here. Although the term "wireless" has until recently implied radio, that is by no means the only wireless media. The *Wireless Headphone* project described in this article uses a different form of wireless link—infrared. Using a 100-kHz frequency-modulated (FM) carrier, the Wireless Headphone has A 4-kHz bandwidth, making it suitable for general-purpose listening. Its high carrier frequency provides interference-free operation, even around most consumer IR remote controls, which operate with a carrier frequency of 40 kHz. And it requires no special connections to the radio or TV.

The power requirements for the system are modest: The transmitter requires a 7- to 14-volt, 200-mA DC supply, while the receiver draws about 10 mA (at minimum volume) from a 9-volt battery. The receiver has a volume control for convenience, although the audio source's volume control may also be used to that end.

The Transmitter Circuit. The transmitter for the Wireless Headphone (see Fig. 1) consists of a pair of infrared LED's and a CD4046 CMOS phase-locked loop (or PLL, which is comprised of two phase comparators, a voltage-controlled oscillator or VCO, a source follower, and a Zener reference)—coupled with a driver transistor. Note that in this application, only the PLL's VCO is used.

The VCO's supply voltage is stabilized by the internal Zener reference. The VCO input at pin 9 is biased near the midpoint of the VCO's linear region. The VCO's programmable sensitivity and high input impedance eliminates the need for signal preconditioning.

Components C1 and R2 provide impedance matching for low-impedance speakers; those components should be eliminated if the audio source has a high impedance (600 ohms). The VCO frequency is set by R4, R5, and C4 for a minimum frequency of 85 kHz, a maximum frequency of 115 kHz, and a nominal center frequency of 100 kHz, which yields a VCO sensitivity of 7.5 kHz/volt.

The VCO output at pin 5 of U1 drives a saturated common-emitter circuit, built around Q1 (a 2N2222A general-purpose NPN silicon transistor). Although U1's Zener reference decouples the VCO from supply variations, the IR-emitter current is not regulated. Components shown in the schematic should be suitable for most applications. The number of IR emitters (on our circuit, LED1 and LED2) connected to the collector of Q1 can be increased to provide increased room coverage, as long as the supply voltage is sufficient to drive the LED string. Allow 1.8 volt per LED, and select R7 so that the peak current through the LED's does not exceed the part specification (typically 100 mA).

The IR transmitter's supply voltage may be an unregulated DC source greater than 7 volts. An internal Zener reference at pin 15 of U1 regulates the supply to 5–6 volts for the VCO. The current through the IR LED's may be adjusted by changing the value of R7 to suit the diode ratings.

Receiver. The schematic diagram of the receiver for the Wireless Headphone—essentially a reverse-biased photodiode detector/amplifier—is shown in Fig. 2. That circuit consists of a CA3237 high-gain IR remote-control preamp (U1), a 4046 phase-locked loop (U2), and an LM386 low-voltage audio amplifier (U3).

Integrated circuit U1—which is designed for 40-kHz carrier systems but can provide limiting action to up to 1 MHz—contains two amplifiers whose gain is set by C6/R4, and C7/R5. Together those components provide DC and low-frequency blocking, while setting the combined gain of the amplifiers to about 85 dB at 100 kHz. The Schmitt-trigger section (pins 4 and 6) of U1 is not used.

The IR remote-control preamp's output at pin 7 is AC coupled to the phase-locked loop, which operates with a 100-kHz center frequency. The PLL's 15-kHz capture range allows for considerable center-frequency mismatch with the transmitter while providing proper demodulation bandwidth and noise rejection. The VCO of the PLL has a range of ± 30 kHz around the center frequency, which also allows for transmitter/receiver mismatch without unduly sacrificing loop performance.

The loop lowpass filter output contains the demodulated audio signal and is internally buffered at pin 10. The audio is filtered and fed through amplitude control R12 to the non-inverting input of U3 (an LM386 low-voltage audio power amplifier), which pro-

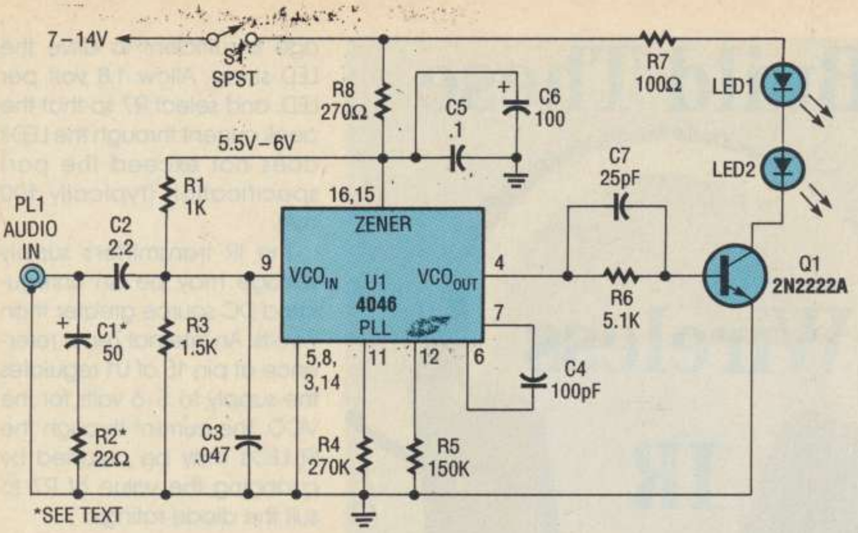

7–14V
S1
SPST
R8
270Ω
5.5V–6V
R1
1K
PL1
AUDIO
IN
C2
2.2
C1*
50
R3
1.5K
R2*
22Ω
C3
.047
9
16,15
ZENER
VCO_IN
U1
4046
PLL
VCO_OUT
4
7
5,8,
3,14
11
12
6
C4
100pF
R4
270K
R5
150K
*SEE TEXT
C5
.1
C6
100
R7
100Ω
LED1
LED2
C7
25pF
R6
5.1K
Q1
2N2222A

Fig. 1. The transmitter for the Wireless Headphone is built around a CD4046 CMOS phase-locked loop or PLL, coupled with a driver transistor, and a pair of infrared LED's. Although the CD4046 is comprised of two phase comparators, a voltage-controlled oscillator (or VCO), a source follower, and a Zener reference, only its VCO is used in this application.

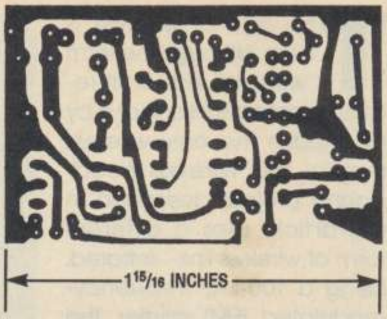

1 15/16 INCHES

Fig. 4. The receiver's full-size printed-circuit layout is shown here.

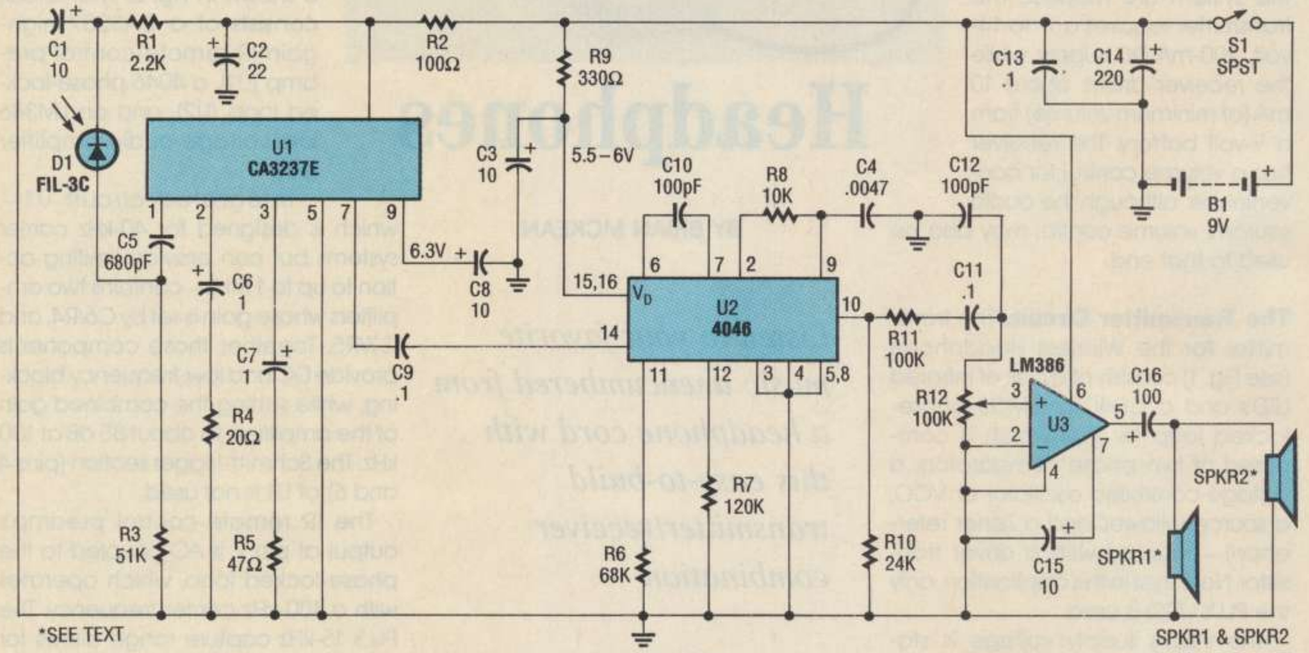

C1
10
R1
2.2K
C2
22
R2
100Ω
R9
330Ω
D1
FIL-3C
U1
CA3237E
1
2
3
5
7
9
C5
680pF
C6
1
C7
1
R4
20Ω
R3
51K
R5
47Ω
*SEE TEXT
6.3V
C8
10
C9
.1
C3
10
5.5–6V
C10
100pF
R8
10K
C4
.0047
C12
100pF
15,16
V_D
U2
4046
6
7
2
9
14
11
12
3
4
5,8
10
R7
120K
R6
68K
C11
.1
R11
100K
R12
100K
LM386
U3
3
6
2
4
5
7
C16
100
SPKR2*
SPKR1*
C15
10
R10
24K
C13
.1
C14
220
S1
SPST
B1
9V
SPKR1 & SPKR2
8–32Ω SPEAKER

Fig. 2. The receiver for the Wireless Headphone consists of a CA3237 high-gain IR remote-control preamp (U1, which is designed for 40-kHz carrier systems.), a 4046 phase-locked loop (U2), and an LM386 low-voltage audio amplifier (U3).

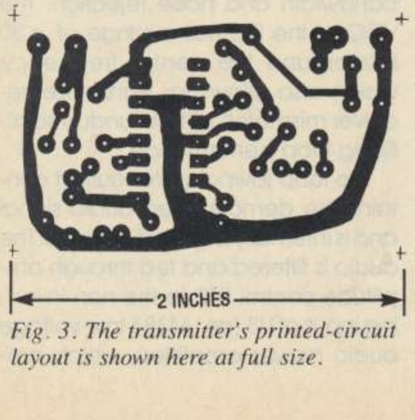


Fig. 3. The transmitter's printed-circuit layout is shown here at full size.

vides a 26-dB gain and will easily drive a paralleled pair of AC-coupled, low-impedance earphones.

Voltage regulation in the receiver is provided by U1 and U2, with the assistance of R2 and R9. The receiver will operate from supply voltages as low as 7 volts, making battery operation (from a rechargeable 9-volt battery) highly practical.

A final note regarding the high-gain receiver: Normal practice would require such a circuit to be enclosed in a metal case to provide electrostatic shielding. That may not be necessary, but is recommended for best range.

Assembly. Most parts are quite noncritical. Many parts can be replaced with near value(s) without affecting the circuit. The exceptions are noted on the schematic diagrams by asterisks—those parts should not be replaced with any other value. If you can not find the specified photodiode, one salvaged from a commercial IR receiver should work well. It should have a capacitance of 30 pF or less at –5 volts, and be 0.1-inch diameter or less. The capacitor should be miniature radial-lead unit.

Figure 3 shows a full-scale template

PARTS LIST FOR THE RECEIVER

SEMICONDUCTORS

U1—CA3237E IR preamplifier (NTE1682), integrated circuit
U2—CD4046B CMOS phase-locked loop, integrated circuit
U3—LM386 low-voltage, audio-power amplifier, integrated circuit
D1—FIL-3C, FIL-5C, PIN-3CD, PIN5D, or similar IR-detector diode

RESISTORS

(All fixed resistors are ⅛-watt, 5% units.)
R1—2200-ohm
R2—100-ohm
R3—51,000-ohm
R4—20-ohm
R5—47-ohm
R6—68,000-ohm
R7—120,000-ohm
R8—10,000-ohm
R9—330-ohm
R10—24,000-ohm
R11—100,000-ohm
R12—100,000-ohm PC-mount potentiometer

CAPACITORS

C1, C3, C8, C15—10-μF, 16-WVDC, radial lead electrolytic or tantalum
C2—22-μF, 16-WVDC, radial lead electrolytic or tantalum
C4—0.0047-μF, ceramic-disc
C5—680-pF, ceramic-disc
C6, C7—1-μF, 16-WVDC, electrolytic
C9, C11, C13—0.1-μF, ceramic-disc
C10, C12—100-pF, ceramic-disc
C14—220-μF, 16-WVDC, electrolytic
C16—100-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

SPKR1—8–32-ohm speaker
S1—SPST toggle switch
B1—9-volt alkaline, or rechargeable battery
Printed-circuit materials, enclosure, earphone jack, 9-volt battery connector, wire, solder, hardware, etc.

PARTS LIST FOR THE TRANSMITTER

SEMICONDUCTORS

U1—CD4046B phase-locked loop (do not use the 74C version)
Q1—2N2222A general-purpose NPN silicon transistor (use TO-18 if driving LED at high current)
LED1, LED2—RS276-143 infrared, light-emitting diode (Radio Shack)

RESISTORS

(All fixed resistors are ⅛-watt, 5% units, unless otherwise noted.)
R1—1000-ohm
R2—22-ohm
R3—1500-ohm
R4—270,000-ohm
R5—150,000-ohm
R6—5100-ohm
R7—100-ohm, ¼-watt
R8—270-ohm, ¼-watt

CAPACITORS

C1—50-μF, 1-WVDC, radial-lead electrolytic or tantalum
C2—2.2-μF, non-polarized multilayer ceramic
C3—0.047-μF, ceramic-disc
C4—100-pF, ceramic-disc
C5—0.1-μF, ceramic-disc
C6—100-μF, 10-WVDC, electrolytic
C7—25-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

S1—SPST switch
Printed-circuit board materials, enclosure, 7- to 14-volt DC, 200-mA source, wire, solder, hardware, etc.

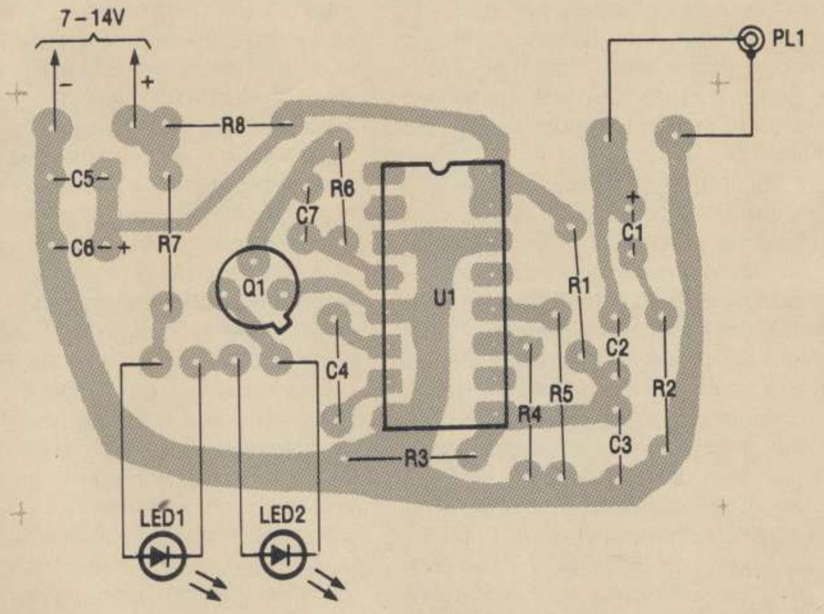


Fig. 5. The size of the parts used to build the transmitter are important due to space constraints, thus, ¼-watt or smaller resistors are a must and miniature (radial lead electrolytic or otherwise) capacitors are recommended.

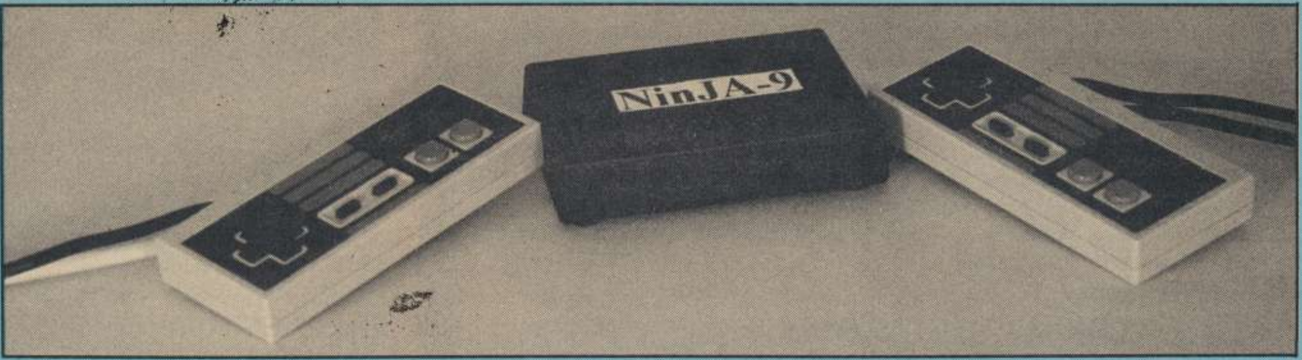
of the transmitter printed-circuit artwork, and Fig. 4 shows a full-scale template of the receiver's printed-circuit artwork. Printed-circuit assembly is recommended, particularly for the receiver, which has a very high gain.

As can be seen from the size of those foil patterns, the most important factor governing the use of a particular component is its physical size. Due to that factor, the smallest sized components available should be used.

Once you have etched your boards and obtained all the parts, assemble the board for the transmitter guided by Fig. 5 and the board for the receiver guided by Fig. 6. The audio and power connections to the receiver board are best handled by case-mounted connectors.

The circuits, once assembled, should operate immediately without adjustment or alignment. The Zener references can be checked at pins 15 and 16 of the CD4046's and at pin 9 of the CA3237. The transmitter and receiver VCO's can be checked at pin 4 of the two CD4046's. The free-running frequency of the transmitter should be 100 kHz ± 10 kHz; and the transmitter and receiver VCO frequencies should be identical when the two units are optically coupled and properly

(Continued on page 92)



Build a Joystick Adapter

Give that old Nintendo joystick a new lease on life with an adapter that makes it compatible with your computer's game port

BY LARRY L. CAMERON

I am 24-years old, and I love frosted flakes. And like millions of adults who don't take themselves too seriously, I would like to add that I enjoy playing a good action-filled computer game from time-to-time as well.

Nothing beats the feeling I get from eliminating a bunch of bad guys or saving the Federation from destruction. For those sessions, a joystick is a must, but lately my computer-compatible joystick has been giving me trouble. Sometimes the game character would stop dead in its tracks only to be blasted to bits. Something had to be done about that old clunker of a joystick.

I looked around for a new joystick, but the ones that caught my eye were too expensive or did not seem to be responsive enough to suit my tastes. If only I could use my faithful Nintendo joystick with games on my computer! I was used to playing games with it; it had nifty features (such as rapid-fire); and it responded quicker than my old PC joystick ever did. If only it could be adapted for use with my computer.

The *Nintendo Joystick Adapter* (*NinJA* for short) described in this article is a circuit that is designed to interface your computer to many different Nintendo Entertainment System ("NES") joysticks that until recently would only work with NES equipment. If you do not own any Nintendo joysticks, perhaps you might reconsider purchasing one. Many offer slick features such as variable/multi-speed rapid fire, infrared-remote operation, and right- or left-handed control, etc.

Compatibility. There are two versions of the NinJA: one, the NinJA-15, is designed for compatibility with all IBM PC/XT/AT/386/486 and compatible computers equipped with a 15-pin game port; the NinJA-9 version is compatible with Atari-style 9-pin game ports for use with computers such as the Commodore Amiga and Atari ST.

The NinJA (referring to both versions) is compatible with all NES-style joysticks whether manufactured by Nintendo or available through a third-party supplier. On the negative side, gadgets such as the Nintendo "Zapper Gun," are functionally different than joysticks and will not be NinJA compatible. There are also several third-party joysticks that support features like "pause" and "slow motion," which are achieved by digitally manipulating the START and SELECT buttons on the Nintendo joystick. Those features do not translate to an equivalent function on your computer. In addition, joysticks designed for use with the Super NES are not compatible with NinJA1.

The NinJA-9 is completely compatible with all software that accepts joystick input on computers like the Commodore Amiga and Atari ST. In fact, the NinJA-9 allows you to use Nintendo joysticks on the whole group of computers that conform to the "standard" Atari-style, 9-pin male connector including the Commodore 64, VIC-20, Atari 800, etc., and it's even compatible with the old Atari VCS video game!

It should not come as any big surprise that the compatibility issue is much more complicated for the NinJA-15, and its interface with the IBM PC computer, since the IBM joystick is directionally analog while the Nintendo joystick is digital. In a nutshell, the NinJA-15 will work with games and programs that expect threshold-joystick input. "Threshold" refers to a software-defined analog-joystick-input value that would have to be met or exceeded by a typical IBM analog joystick to begin screen movement at a constant rate. Once that threshold is met or exceeded, movement begins.

That concept is better described than defined: if you move an analog joystick one quarter way to the left, your screen character will not move in a game that arbitrarily defines "left" to be a maximum stick deflection to the left; so screen character movement begins only with the analog joystick handle moved completely to the left. The NinJA-15 overcomes that problem by generating a relative "maximum/minimum" analog signal for each of the eight (N, S, E, W, NE, NW, SE, and SW) directions.

On the downside, compatibility with all IBM software that accepts joystick input cannot be guaranteed.

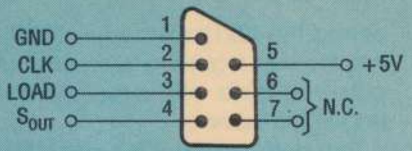


Fig. 1. Here is a pinout diagram of the Nintendo-joystick connector.

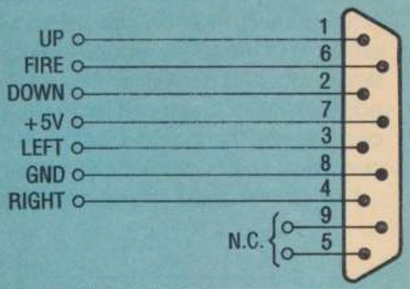


Fig. 2. This is a pinout diagram giving the signals associated with an the Atari-style joystick connector. That joystick, which was first popularized with the introduction of the Atari VCS video-game system some years ago, is digital in nature.

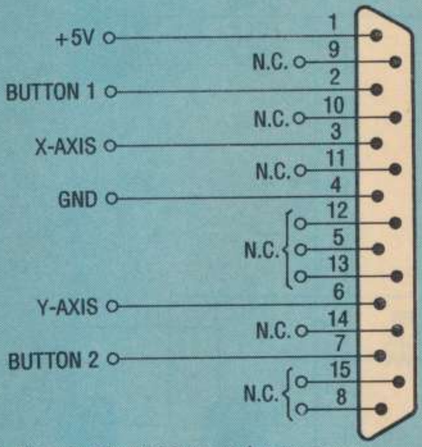


Fig. 3. The IBM joystick port uses a female DB-15 connector; the pinout and relevant signal descriptions for that connect are shown here.

PARTS LIST FOR THE NINTENDO JOYSTICK ADAPTER

SEMICONDUCTORS

U1—74HC595 high-speed CMOS 8-bit latched shift register, integrated circuit
U2—74HC190 high-speed CMOS synchronous decade counter/divider, integrated circuit
U3—LM7555 CMOS oscillator/timer, integrated circuit
Q1, Q2—2N4403 PNP transistors or equivalent (see text)
D1–D4—1N914 or equivalent general-purpose silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—5,600-ohm
R2—120,000-ohm
R3, R5, R6—2200-ohm
R4—330-ohm
R7—47,000-ohm × 4, 8-pin SIP resistor array

CAPACITORS

C1, C2—0.1-μF, ceramic-disc
C3, C4—1.0-μF, 16-WVDC, tantalum
C5—0.01-μF, ceramic-disc
C6—0.001-μF, ceramic-disc
C7, C8—47-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

PL1—DB-9 female (NinJA-9) or DB-15 male connector (NinJA-15), see text
PL2—Male NES connector with cable
Printed-circuit materials, enclosure (Serpac model 031), IC sockets, wire, solder, hardware, etc.

Note: The following items are available from Larry L. Cameron (7020 Grand Canyon #243, Austin TX 78752; Tel. 512- 467-9532): the NinJA printed-circuit board for $5.00; NinJA kit including printed-circuit board and all components (excluding cables) for $10; NinJA kit including printed-circuit board, all components, and cables for $15.00; Completely assembled NinJA (specify NinJA-9 or NinJA-15) for $20.00. Texas residents, please add appropriate sales tax. Please add $2.00 for shipping to all orders.

While most available games operate by way of threshold input and will, therefore be compatible with NinJA-15, software expecting analog (linear, non-threshold) joystick input will not operate properly with the NinJA-15. An example of that is a flight simulator in which the rate of turn of the airplane is dictated by how far the joystick moves to the left or right.

PC and Nintendo Joysticks. The Nintendo joystick is a very simple digital device that consists of a 4021 CMOS parallel-in/serial-out shift register, with eight pulled-up SPST momentary switches connected to its parallel inputs. The Nintendo computer provides the necessary clock and parallel-load signals to the shift register when the joystick is connected. Figure 1 is a functional pinout diagram of the Nintendo-joystick connector.

Figure 2 is a functional pinout diagram of the Atari-style joystick connector. That joystick—first popularized with the introduction of the Atari VCS video-game system some years ago—is also digital in nature. It was adopted by Commodore and Atari for use with their home-computer systems and is still supported today in their line of Amiga and ST computers. The joystick itself consists of five normally open, SPST momentary-contact switches—four for the cardinal directions and one for "fire"—which (connected through the computer's male DB-9 joystick port) go to ground when thrown.

The IBM PC joystick, which is part analog and part digital, consists of two potentiometers (which are used to indicate the linear X-Y position of the joystick handle) and two normally open SPST momentary contact switches (which are used as "fire" buttons); like the Atari-style joystick, they too are grounded upon switch actuation. A female DB-15 connector on the computer is used for the physical connection of the joystick to the PC and is usually provided on the motherboard or via a bus-expansion card such as a dedicated game card or multi-I/O card.

Figure 3 is a pinout diagram of the IBM DB-15 joystick connector showing the arrangement and signal descriptions of relevance to the NinJA-15.

Theory of Operation. Figure 4 is a schematic diagram of the NinJA, which consists of a serial-to-latched-parallel data interface that allows a Nintendo joystick to emulate Atari-style joysticks. For IBM-style joysticks, additional digital-to-analog circuitry is included to synthesize the necessary analog directional signals.

The NinJA supplies power, ground, a clock signal, and parallel-load signals to the Nintendo joystick (which are normally provided by the Nintendo game system) to make the joystick functional outside of its intended NES connection. Since the NinJA draws

TABLE 1—NINJA TO COMPUTER JOYSTICK CONNECTIONS

	DB9	connect to ——→	PL1
NinJA-9	Pin 1	Up	Pin 6
	Pin 2	Down	Pin 8
	Pin 3	Left	Pin 4
	Pin 4	Right	Pin 7
	Pin 6	Button A	Pin 3
	Pin 7	V_{CC} (+5V)	Pin 2
	Pin 8	GND	Pin 1
	DB15	**connect to ——→**	**PL1**
NinJA-15	Pin 1	V_{CC} (+5V)	Pin 2
	Pin 2	Button A	Pin 3
	Pin 3	Pot. X	Pin 10
	Pin 4	GND	Pin 1
	Pin 6	Pot. Y	Pin 9
	Pin 7	Button B	Pin 5

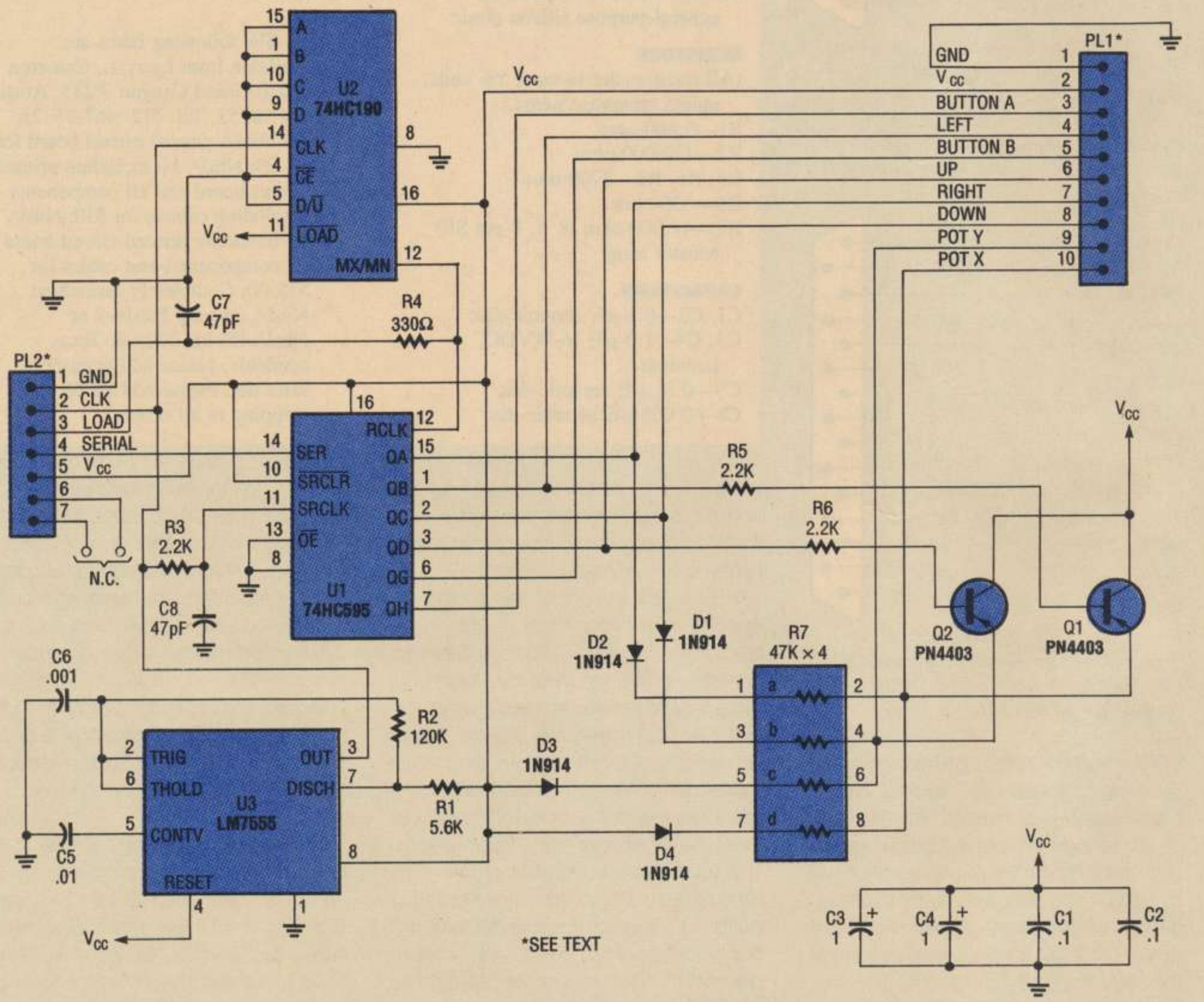

U2 74HC190
A
B
C
D
CLK
CE
D/U
LOAD
MX/MN
V_{CC}
C7 47pF
R4 330Ω
PL2*
1 GND
2 CLK
3 LOAD
4 SERIAL
5 V_{CC}
6
7
N.C.
R3 2.2K
C8 47pF
U1 74HC595
SER
SRCLR
SRCLK
OE
RCLK
QA
QB
QC
QD
QG
QH
PL1*
GND
V_{CC}
BUTTON A
LEFT
BUTTON B
UP
RIGHT
DOWN
POT Y
POT X
R5 2.2K
R6 2.2K
Q2 PN4403
Q1 PN4403
D1 1N914
D2 1N914
R7 47K × 4
a
b
c
d
C6 .001
C5 .01
U3 LM7555
TRIG
THOLD
CONTV
RESET
OUT
DISCH
R2 120K
R1 5.6K
D3 1N914
D4 1N914
C3 1
C4 1
C1 .1
C2 .1
*SEE TEXT

Fig. 4. The schematic diagram of the NinJA (shown here) reveals that the NinJA is fundamentally, a serial-to-latched-parallel data interface.

power from the joystick port of the computer to which it's connected, the NinJA is comprised of CMOS IC's.

A 7555 CMOS oscillator/timer (U3) is configured as an astable multivibrator, and is used to generate clock pulses with a 95% duty cycle at 10 kHz. That clock signal is routed to the CLK input of the 4021 (of the Nintendo joystick) and also to the CLK input of U2, a 74C190 CMOS decade counter/divider, which provides the 4021 with the necessary active-high parallel-load signals. When a load signal is received, the 4021 jams the switch status into the shift register and serially outputs that data with every positive edge of the clock.

That data arrives at the serial input of U1 (a 74C595 CMOS 8-bit serial-in/parallel-out shift register with parallel data latches); the non-cascaded two extra bits of the 10-bit serial stream are simply clocked out. When the positive edge of the load signal is received, U1 also latches the parallel data, which consists of switch-closure information.

Not all Nintendo joysticks are created equal; differences in some joystick construction make it necessary to use an RC network (which consists of C7 and R4 in Fig. 4) that provides a delayed load signal for the joystick's internal shift register. That ensures that the parallel data of U1 is

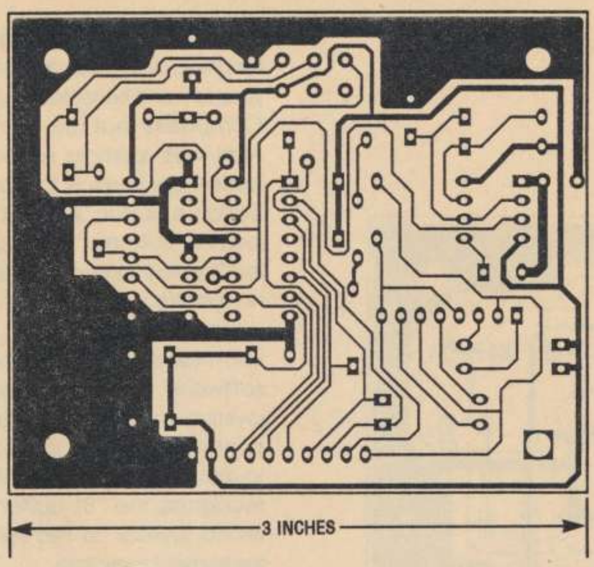


Fig. 5. Both versions of the NinJA were built on the same single-sided printed-circuit board; a template of the pattern is shown here full size.

latched at the proper position. (The values of C7 and R4 shown were determined by trying out several Nintendo joysticks and adjusting the component values until the parallel signals were latched at the expected bit position of U1 with all the various joysticks.)

In the NinJA-9, the latched active-low parallel outputs of U1 (which indicate a switch closure on the Nintendo joystick) are routed to the computer to function as the computer-joystick signals. In the NinJA-15, those output signals are manipulated by the digital-to-analog circuitry that consists of D1–D4, R5–R7, Q1, and Q2 to synthesize the analog signals that the IBM PC recognizes as directional movements of the joystick.

IBM PC Joysticks. In the case of a regular IBM analog joystick, some tweaking of its potentiometers is usually required during the initial set up to "electrically center" the joystick; each program that accepts joystick input must be told ahead of time what values it can expect for minimum and maximum X- and Y-axis stick movement. That process is circumvented by the NinJA-15's somewhat unusual digital-to-analog circuitry.

Although that circuit is not "digital-to-analog" as in the usual sense—outputting an analog signal whose magnitude varies with an n-bit wide digital input—the NinJA-15's DAC will output one of three possible analog signals to function as the X signal (right/left movement along the X axis), and one of three possible analog signals to function as the Y signal (up/down movement along the Y axis), depending on the status of the switches on the Nintendo joystick. With the joystick's handle is centered, the X- and Y-axis signals fed to the joystick port are approximately 0.1 mA.

With the handle in the southeast corner, both the X- and Y-axis the currents drop to exactly half (0.05 mA). In the northwest corner, the currents for both the X- and Y-axis signals will make a large jump (to about 2 mA). Although those values are cited as examples and vary slightly between IBM-compatible PC's and analog joysticks, the relative magnitudes always exhibit the same behavior, and it is that property that is exploited by the NinJA-15 to make it appear that there is a true analog joystick connected to the IBM-compatible computer when in reality there is none.

Without any button pressed on the Nintendo joystick, all the parallel outputs of U1 are high, forward biasing D1 and D2. That, in turn, reverse biases Q1 and Q2, in conjunction with the continually forward-biased D3 and D4, which function to set up a minimum baseline current. That emulates an "electrically centered" analog joystick.

When the RIGHT button on the Nintendo joystick is closed, D1 becomes reverse biased (U1 pin 15 goes low) and the X-axis current will be cut exactly in half since the voltage drops across D1 and D3 are identical.

When the LEFT button is closed, U1 pin 1 goes low, forward biasing Q1, sourcing around 2 mA for the X-input with a small contribution from D1 and D3 thrown in for good measure. The handling of Y axis is analogous to the X axis. The NinJA-15 owes its "auto-centering" to the fact that the voltage drops across the paired diodes D1/D3 and D2/D4 will always be the same (assuming paired diodes of identical composition).

Construction. Both versions the NinJA were built on the same single-sided printed-circuit board as shown in Fig. 5 (which is available alone, as part of a kit of parts, or as a fully assembled unit from the supplier listed in the Parts List). Its corresponding parts-placement diagram is shown in Fig. 6; note that the connector shown here for PL1 corresponds to that of the NinJA-9 version. There are also three jumpers that need to be placed on the board.

Depending on whether you build the NinJA-9 or NinJA-15 version, the DB-9/DB-15 cable connection to the NinJA will be different; Table 1 shows the proper connections to configure the NinJA printed-circuit board for the desired version. If you opt to build the NinJA-9, components D1–D4, R5–R7, Q1, and Q2 are unnecessary.

If desired, you can solder the Nintendo joystick connections directly to the NinJA printed-circuit board at PL2 (as shown in Fig. 6), but for maximum flexibility in switching between joysticks or using the same joystick with a Nintendo game, it is recommended that you purchase a Nintendo-joystick connector cable. Such cables, which are usually billed as "extension cables," are readily available at retailers dealing in Nintendo-related products.

Prepare the cable by cutting the female connector from the cable and retaining the male connector along with the cable. Remove a length of the outer insulation from the end of the cable, then strip the insulation from the inner wires and solder the wires to the NinJA printed-circuit board at the proper positions. Use an ohmmeter to verify pin-to-conductor continuity before soldering the conductors to the board. Plug PL2 is represented in the parts-placement diagram as a Nintendo joystick connector to aid in assembly.

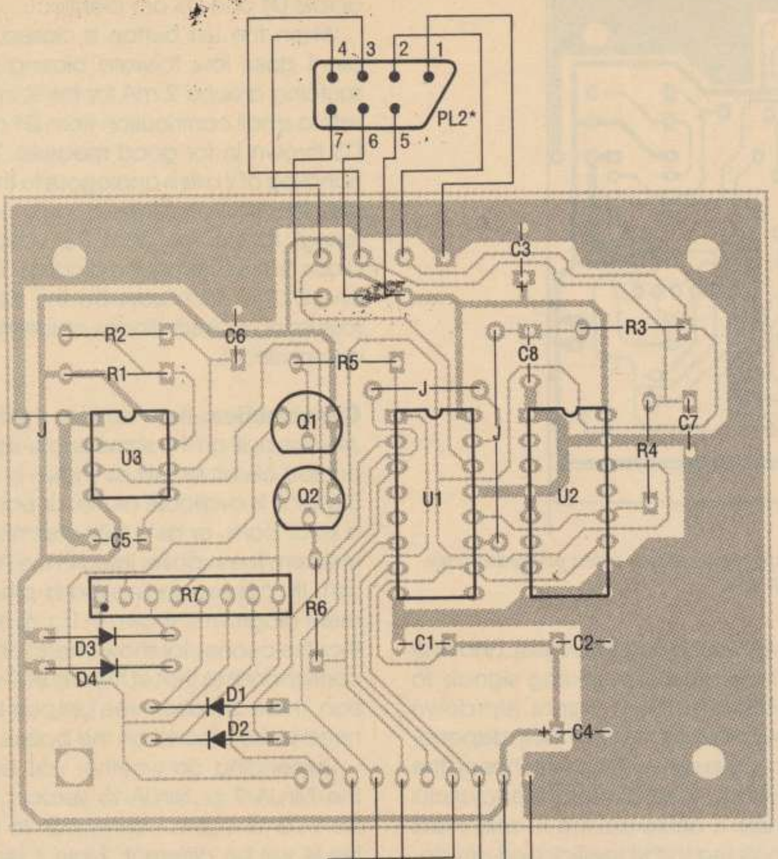


Fig. 6. Although both versions of the NinJA were assembled on the same printed-circuit board, the two versions do differ in some small way. Refer to the text to determine how the version you choose should be assembled, and refer to Table 1 for PL1 wiring instructions that go with your version.

Care should be taken when installing U1–U3 since CMOS devices are sensitive to electrostatic discharge. Also verify that all polarized components and parts with specific pin orientations (such as the transistors, diodes, and IC's) are properly aligned before soldering them in place.

If you have trouble getting the SIP resistor network (R7), it can be replaced by 4 discrete 47k resistors. Under that circumstance, try to match their actual values as closely as possible. After all the parts have been soldered in place, perform the usual checks for misplaced components, cold solder joints, solder bridges, etc.

The printed-circuit board was designed to fit into an attractive Serpac manufactured enclosure (model 031) available from Digi-Key Corp. (701 Brooks Ave., P.O. Box 677, Thief River Falls, MN 56701-0677; Tel. 800-344-4539) and other sources. Holes in the front and rear of the enclosure were drilled for the two protruding cables, and rubber feet with adhesive backing were placed on the bottom to help prevent the NinJA from sliding around.

Set-up and Use. The NinJA-9 requires no adjustment or calibration of any sort. Just plug it into your computer and a Nintendo joystick into the NinJA-9, and you are ready to play your favorite senselessly violent game! Computers that are compatible with Atari-style joysticks support only one button per joystick; the action or "fire" button is button "A" on your Nintendo joystick. Buttons "B," "start," and "select" on the Nintendo joystick will have no function.

However, it has come to my attention that some of the newer Amiga software will recognize a second joystick button. If desired, you may connect pin 9 of the DB-9 connector to pin 5 of PL1 to get the circuit to recognize the "B" button of the Nintendo joystick as the second button for some programs.

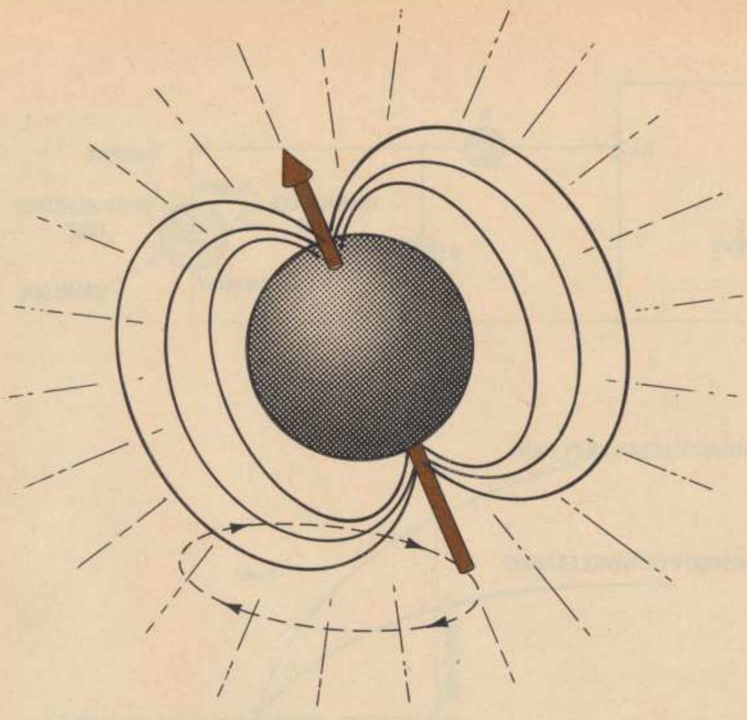
NinJA-15, unlike a typical IBM analog joystick, requires no adjustment or hardware calibration. Since the NinJA-15 sports "auto-centering" circuitry, there are no potentiometers to tweak and no hardware-calibration programs to run. Like the NinJA-9, just plug the NinJA-15 into your computer and a Nintendo joystick into the NinJA-15, and you are ready to play! Don't be surprised, however, if when the program is executed, you are asked something like "move joystick to northwest corner and hit a button" or something similar. That's a calibration throwback for software users who own analog joysticks.

IBM computers equipped with game cards/game ports support two action buttons per joystick; your computer will recognize button "A" of your Nintendo joystick as button 1 and button "B" as button 2. The "start" and "select" buttons on the Nintendo joystick will have no function on your computer.

Troubleshooting. If you have any trouble with your NinJA, the problem could be originating either within your computer or within the NinJA. If you own a regular computer joystick, try plugging it in and seeing if the problem persists. If so, the problem lies with your computer, its joystick port, or possibly the program. If not (or you don't have a regular computer joystick), try the following:

1. Make sure the NinJA has been assembled correctly. Check for incorrectly oriented components, cold solder joints, etc.

(Continued on page 91)



What are Electrons Made of?

We trace the trail of discoveries that lead to our modern understanding of the electron.

BY DAN BECKER

Many of the appliances and devices that make our lives easier, more enjoyable, entertaining, and informed, depend upon our ability to control and manipulate electrons. Electrical current is a flow of electrons, and it is the driving impetus behind many of today's technological advancements and those of the near future. Although we have countless uses for electricity, and power plants are a prominent part of our culture, do we know what electrons are made of?

The Electron is Found. As early as about 800 B.C., the Greeks recorded observing the electric phenomenon produced by rubbing amber. In fact, our word "electron" comes from the Greek word for amber: *elktron.*

In 1600, William Gilbert (1540–1603) recorded that electrification was not limited to amber, but was a more generalized phenomenon. Toward the end of the 1700's, induction-type generators were available. These were capable of producing high voltage, but very little amperage (*i.e.*, they produced static electricity).

About the year 1785 Charles Coulomb (1736–1806) discovered the inverse-square law of electrostatic attraction, who's mathematical relationship is similar to that of the force of gravity. As shown in Fig. 1, we can use this law to depict an electron's force field as directional arrows emanating from an electron's center.

Another important breakthrough occurred in 1772 when a physicist named Alessandro Volta (1745–1827) (after whom the volt is named) discovered a difference in potential between two dissimilar metals in contact with an electrolyte. By 1800 he had a working battery!

With the proliferation of batteries, scientists were now more curious than ever about the source and nature of electric charge. It was during the 1820's that Michael Faraday (1791–1867) discovered the relationship between magnetism and electricity. He discovered that a moving electric charge (an electric current) produces a magnetic field.

In 1864 James Clerk Maxwell (1831–1879) formulated equations that combined Coulomb's equations for electrostatic force with Faraday's work on moving electric charge. Without any additional information, Maxwell's equations made two important revelations. Firstly, that an accelerating electric charge radiates an electromagnetic wave. Secondly, that the resulting electromagnetic wave propagates at 300,000-meters-per-second. From that point forward, research into the nature of electric charge has depended heavily on our understanding of electromagnetic waves and their experimental use.

As technology expanded, new instruments and techniques for investigating the smallest parts of matter became available. By April 1897 it was understood that electrically charged particles are emitted when a metal wire is heated in a vacuum (the ancestor of our cathode-ray tube). In 1891, the particle was named the "electron."

Quanta are Noted. During the late 1800's, numerous attempts to explain blackbody radiation were unsuccessful. Ideally, a blackbody is an object that absorbs all wavelengths of electromagnetic radiation. Conversely, as an ideal blackbody is heated, it begins to radiate all wavelengths of radiation. However the radiated power is not equal at all wavelengths, but peaks at a certain wavelength (depending upon the blackbody's temperature).

In 1900 Max Planck (1858–1947) discovered a mathematical formula that completely agreed with the experimental results. His formula marked the beginning of a entirely new way of defining how matter and energy interact. Basically, he assumed that a blackbody consists of countless little electromagnetic transmitters (not an entirely new idea). The new part of Planck's concept was to say that these tiny electromagnetic transmitters could only emit or absorb energy in

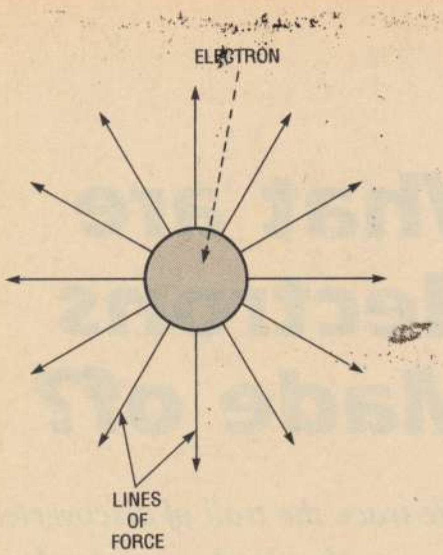


Fig. 1. Coulomb's electron may be visualized as a tiny sphere with electric lines of force radiating out in all directions.

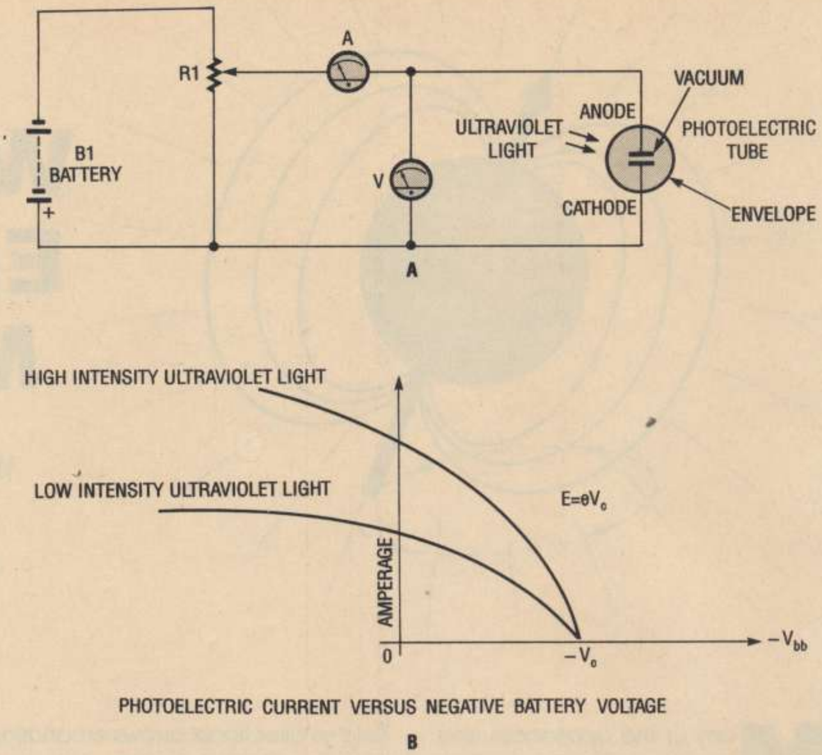

R1
A
B1
BATTERY
V
ULTRAVIOLET LIGHT
ANODE
VACUUM
PHOTOELECTRIC TUBE
CATHODE
ENVELOPE
A
HIGH INTENSITY ULTRAVIOLET LIGHT
LOW INTENSITY ULTRAVIOLET LIGHT
E=eV₀
AMPERAGE
0
−V₀
−V_bb
PHOTOELECTRIC CURRENT VERSUS NEGATIVE BATTERY VOLTAGE
B

Fig. 2. The circuit in A is typical of those used to measure an electrons kinetic energy. The test procedure used results in a graph such as that shown in B.

little packages called "quanta." Planck's law:

$$E = nhf$$

defines this relationship. There, E is the total energy (in joules); n is a positive whole number (integer) accounting for a given number of energy units (quanta); h is Planck's constant: (6.626 $\times 10^{-34}$ joule-seconds); and f is the frequency (in hertz) of the electromagnetic wave. As you can see, this formula restricts electromagnetic waves to whole-number multiples of the fundamental unit of energy, h. In addition, this formula tells us that high-frequency electromagnetic radiation packs more energy than low-frequency radiation. This quantitative approach to energy marked the birth of quantum theory.

A few years earlier, in 1887, Heinrich Hertz (1857–1894) had been experimenting with a spark gap. His apparatus consisted of a metallic cathode (electron emitter) and anode (electron absorber) suspended in a vacuum bottle. When he connected a battery across the electrodes, Hertz found that an electric current would flow through the vacuum, but only while the spark gap was exposed to light; in total darkness no current would flow.

In 1902 this phenomena was further investigated using a circuit similar to the one shown in Fig. 2A. It was found that high-frequency light (ultraviolet) is much better at liberating electrons from the cathode's surface. In addition, no electrons are ejected if the frequency is decreased below a certain value, regardless of the light's intensity.

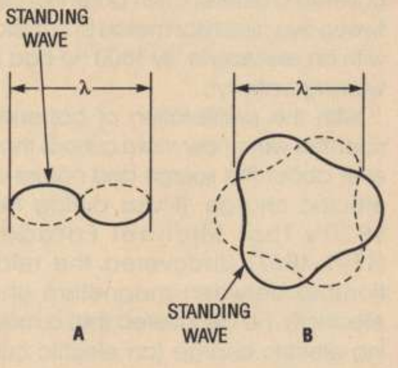


Fig. 3. Like an oscillating string fastened at both ends (A), an integral number of de Broglie wavelengths must fit into Bohr's electron orbits (B).

When illuminated by ultraviolet light at different intensities, a negative voltage must be applied to the spark-gap's anode (as shown in Fig. 2A) to completely stop all current flow. In other words, ultraviolet light ejects electrons from the cathode with enough kinetic energy so that they can still overcome an opposing battery potential (a small negative electric field). This is shown graphically in Fig. 2B. Here the kinetic energy (eV_c) does not depend upon the light's intensity, since all values of intensity intersect the cutoff point at the same negative voltage $-V_c$! This phenomenon was named the photoelectric effect, and Hertz is credited with its discovery.

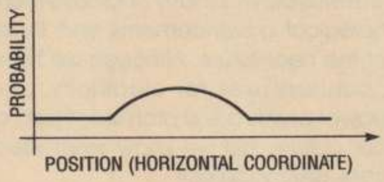


Fig. 4. This curve shows the probability of finding an electron in a given place at a given instant.

A Partial Explanation. At this time, most scientists believed that light was a wave phenomena, not a particle. In fact, as far back as 1801 Thomas Young's (1773–1829) double-slit experiment (more about that later) clearly demonstrated that light ex-

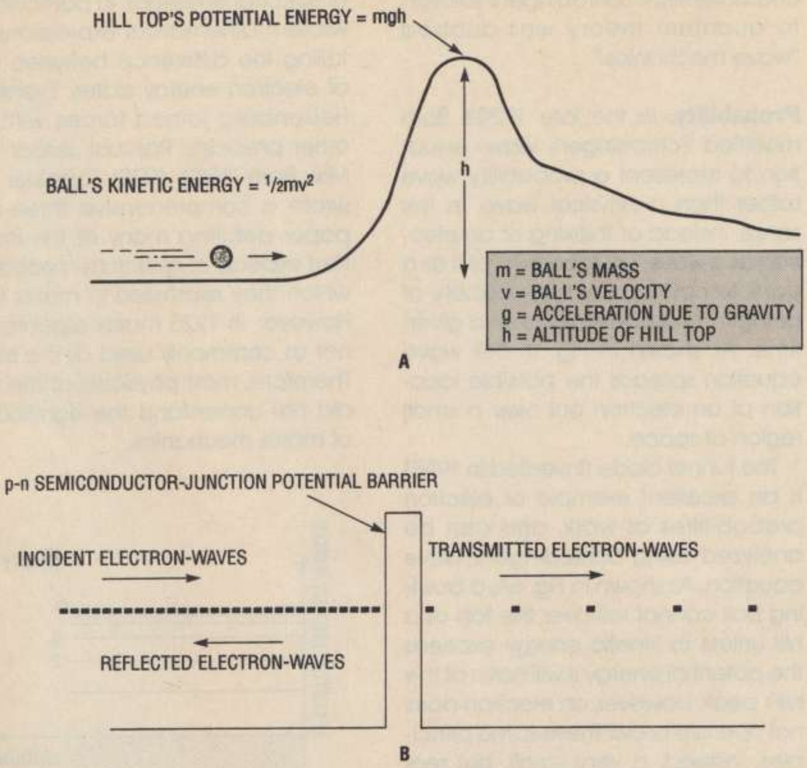

HILL TOP'S POTENTIAL ENERGY = mgh
BALL'S KINETIC ENERGY = $\frac{1}{2}mv^2$
h
m = BALL'S MASS
v = BALL'S VELOCITY
g = ACCELERATION DUE TO GRAVITY
h = ALTITUDE OF HILL TOP
A
p-n SEMICONDUCTOR-JUNCTION POTENTIAL BARRIER
INCIDENT ELECTRON-WAVES
TRANSMITTED ELECTRON-WAVES
REFLECTED ELECTRON-WAVES
B

Fig. 5. The bowling ball's kinetic energy must exceed the hill's potential-energy barrier if it is to make it to the other side (A). However, electrons can "tunnel" through a potential barrier when they cannot overcome it (B).

hibits the interference behavior characteristic of waves. However, waves cannot account for the photoelectric effect, otherwise the electron's kinetic energy would increase as the light becomes brighter.

In 1905 Albert Einstein introduced his Special Theory of Relativity. Due to the results of that theory, Einstein became convinced that Planck's concept of light quanta was real. In addition, he was able to write a mathematical expression explaining the photoelectric effect. In 1916, Robert Millikan (1868–1953) confirmed Einstein's theory. Thus, when an electron absorbs a quanta (named a "photon" in 1926 by Gilbert Lewis) of energy, the electron's kinetic energy increases by a fixed amount. However, since there were many experiments that clearly demonstrated the wave nature of light, most scientists still believed that light was a wave.

Up to that point in history, the concept of an atom as we know it today was not proposed. In addition, a lot of the work in quantum theory was based on experiments with emission spectra. That is, trying to explain how and why certain elements like hydrogen would only emit or absorb narrow segments of the electromagnetic spectrum. However, it was becoming clear that light energy and electrons worked together to generate this phenomena.

In 1911 another important development occurred. After experimenting with radioactive substances, Ernest Rutherford (1871–1937) proposed the now-famous planetary model of a hydrogen atom. His model placed a negatively charged electron in orbit around a positively charged nucleus (proton). According to Rutherford's model, as an electron moves closer to the nucleus, its energy level decreases and the excess energy is radiated out into space in the form of electromagnetic waves. Unfortunately however, this simple model allows an atomic electron to emit a continuous spectrum of wavelengths (energy levels), which does not agree with experimental findings.

In 1913 Neils Bohr (1885–1962) used Planck's energy quanta along with Einstein's explanation of the photoelectric effect to improve Rutherford's model of a hydrogen atom. Bohr's model is based on two assumptions: 1) an electron's orbit is restricted to discrete values; 2) if an electron absorbs a quantum of energy it jumps to a higher orbit; if it emits a quantum of energy it jumps to a lower orbit. The energy in the quantum absorbed or emitted must equal the difference in the energy levels of the two orbits.

Since Bohr's atomic electrons are restricted to specific orbits, they can only absorb or emit specific wavelengths of energy (a good example is the orange glow of a neon lamp). Although this model was in better agreement with experimental findings, Bohr did not know why electrons are restricted to certain orbits.

Electron Size? In 1923 an American physicist named Arthur Compton (1892 1962) showed that X-rays can bounce off of an electron. The effects are similar to two colliding billiard balls (the difference is that when an X-ray gives up some of its momentum to an electron, instead of changing velocity as a billiard ball would, the X-ray changes frequency). Thus, by 1923 it was demonstrated that an electromagnetic wave (in this case, an X-ray) can also behave like a particle.

At this point in history it was possible (but erroneous) to ascribe physical dimensions to an electron. One could imagine it to be a tiny sphere. Using the information known at that time, Hendrik Antoon Lorentz (1853–1928) introduced a classical model in which the electron is a tiny sphere. In his model, the energy in the electric field surrounding the electron and outside a radius (r), is given by the formula:

$$E = e^2/r$$

Assuming that all of an electrons energy is contained in its electric field (which is erroneous), then this energy must equal mc^2 (as given by Einstein's formula, $E = mc^2$, for an electron at rest). We know an electron's charge ($e = 4.803 \times 10^{-10}$ electrostatic units or 16.021×10^{-20} coulombs); and mass ($m = 9.109 \times 10^{-28}$ grams). Therefore, since $E = mc^2 = e^2/r$:

$$r = e^2/mc^2 = 2.8 \times 10^{-13} \text{ cm}$$

In the old way of thinking (classical mechanics), this is an electron's minimum radius.

Wave Mechanics. During the 1920's quantum theory progressed to a much more mature level. Many new ideas and theories were presented in rapid succession. The emphasis was on trying to explain and characterize the behavior of atomic electrons. In general, this amounted to examining the emission spectra of hydrogen and other elements and then finding a mathematical expression to define all of the possible energy states or levels.

Beginning as early as 1922, physicist Louis de Broglie (1892–1987) had a new idea. He thought that if light waves can act like particles, why can't particles act like waves? De Broglie's theory determined a particle's wavelength to be:

h/mv

where h is Planck's constant, m is the particle's mass, and v is its velocity.

In addition to assigning a wavelength to an electron, de Broglie used his particle/wave idea to explain why electron orbits are limited to specific radii. Although a single electron may occupy one orbital ring, an integral number of wavelengths must be used to determine the orbital ring's circumference. As shown in Fig. 3, one can envision standing waves encircling a nucleus. De Broglie found that his wavelengths fit precisely into Bohr's orbital radii! Initially this concept was not accepted. However, in 1927 two American scientists, C.J. Davisson and L.H. Germer, conducted additional experiments that completely verified the wave nature of electrons. They did this by scattering a beam of electrons off of a crystalline lattice of atoms. A diffraction pattern was obtained and its wavelength corresponded to de Broglie's wavelength for electrons.

In 1925 Erwin Schrodinger (1887–1961) heard about de Broglie's matter/wave concept. This appealed to Schrodinger because he was looking for a physical explanation for the restricted electron orbits. Using this and Bohr's model of the atom, Schrodinger developed a very sophisticated wave equation. Initially, Schrodinger assumed that electrons were actually physical waves just like water or sound waves—an assumption that, again we now know is incorrect. However, it made his wave equations very appealing. In addition, it brought about wide acceptance of the idea that all matter and energy have both wave and particle characteristics. Schrodinger's solution to quantum theory was dubbed "wave mechanics."

Probability. In the late 1920's, Borh modified Schrodinger's wave equation to represent a probability wave rather than a physical wave. In this sense, instead of thinking of an electron as a wave, you can think of it as a particle having only a probability of being in any given place at a given time. As shown in Fig. 4, the wave equation spreads the possible location of an electron out over a small region of space.

The tunnel diode (invented in 1958) is an excellent example of electron probabilities at work, and can be analyzed using Schrodinger's wave equation. As shown in Fig. 5A, a bowling ball cannot roll over the top of a hill unless its kinetic energy exceeds the potential energy it will have at the hill's peak. However, an electron does not operate under these same principles. Instead, a very small, but real probability exists that an electron can appear on the other side of the energy barrier (hill top).

Even though (in classical terms) an electron may not have enough kinetic energy to transverse an energy barrier, if it gets close enough, and the barrier is thin enough, there will be a small probability that it will suddenly appear on the other side! As shown in Fig. 5B, most of the electron-waves traveling toward the diode's PN junction (energy barrier) are reflected back. However, the wave equation says that a small number of these electron-waves have a chance of being found on the other side of the junction (energy barrier or hill top). Moreover, those that do appear on the other side of the p-n junction have the same energy they started with! It is as though they tunneled right through the barrier unimpeded!

Another physicist working in Europe in the mid 1920's was Werner Heisenberg (1901–1976). Heisenberg's approach was very different than Schrodinger's. To begin with, he discarded analogies that were not based on experimental findings. These included the idea that electrons orbit an atom's nucleus. There was no experimental evidence supporting this idea. Instead, Heisenberg concerned himself with the evidence of spectral emissions. In particular, he wrote mathematical expressions detailing the difference between pairs of electron energy states. Eventually, Heisenberg joined forces with two other physicists, Pascual Jordan and Max Born (1882–1970). Together they wrote a comprehensive three-man paper detailing many of the important aspects of quantum mechanics, which they expressed in matrix form. However, in 1925 matrix algebra was not as commonly used as it is today. Therefore, most physicists at the time did not understand the significance of matrix mechanics.

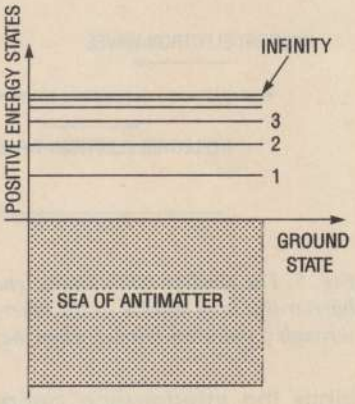


Fig. 6. Dirac's atomic model predicts a sea of antimatter energy states filled with electrons below the ground state of normal electrons.

Fortunately however, Paul Dirac (1902–1984) was given a copy of the three-man paper (as it was called). Dirac quickly saw the connection between their work and that of William Hamilton. During the late 1820's, William Hamilton (1805–1865) developed a very useful set of matrix equations. Hamilton's equations can be used to describe wave motion or particle motion.

In light of Hamilton's equations, Dirac reworked the matrix mechanics of the three-man-paper. In addition, he invented his own mathematics that he called quantum algebra. Dirac's first paper on quantum mechanics was published in 1925. Over the next few years Dirac added to his original work. Dirac's equations are more general and complete in that they include Schrodinger's wave mechanics and the three-man team's matrix mechanics as special cases. In addition, Dirac's quantum mechanics automatically included the more subtle aspects of atomic-electron behavior, as well as satisfying the requirements of Einstein's special relativity. Dirac's equations were so effective that they could actually determine the recoil motion of an atom that occurs when an electron emits a photon.

Antimatter However, Dirac's relativistic wave equations had a curious twist. In addition to all of the possible positive energy states that an electron may occupy, Dirac's equations implied that there are negative energy states as well!

Figure 6 is a simplified illustration of Dirac's explanation of this finding. There a horizontal line represents the ground state, or an electron's lowest energy state. Moving vertically up the y-axis represents moving to higher energy states. Electrons filling positive energy states are allowed to exist only at those levels (states) indicated by horizontal lines. It requires a photon of energy (equivalent to the difference in the initial and final states) to boost an electron up vertically on the scale (into a more energetic energy state). Moreover, all electrons will spontaneously eject excess energy and drop into a lower energy state if such a position is available.

In addition to all possible positive energy states, there is a large well of negative energy states existing below the ground state. All electrons would fall into this huge reservoir and vanish forever except, as Dirac proposed, it is already filled up with electrons! Lucky us!

Interestingly enough, Dirac calculated just how much energy would be required to kick one of those negative-energy electrons up into a positive energy state—where it could be seen! However, that is not all: doing so would leave behind a hole, or a vacancy on the negative-energy side. The hole can be interpreted as a particle with the same mass, but an electric charge *opposite* to that of the electron. This particle was discovered in 1932 by C.D. Anderson (and others) and was named the "positron."

A positron is the exact opposite of an electron and is therefore referred to as an "antimatter" particle. Positrons are readily produced in particle accelerators and even in nature. When an electron and positron collide, both vanish leaving behind high-energy gamma rays (photons). Conversely, the transmutation of a high-energy gamma ray into an electron-positron pair is also possible! The study of the interaction of particles with the sea of negative-energy electrons is an important branch of physics that has led to many new ideas and theories.

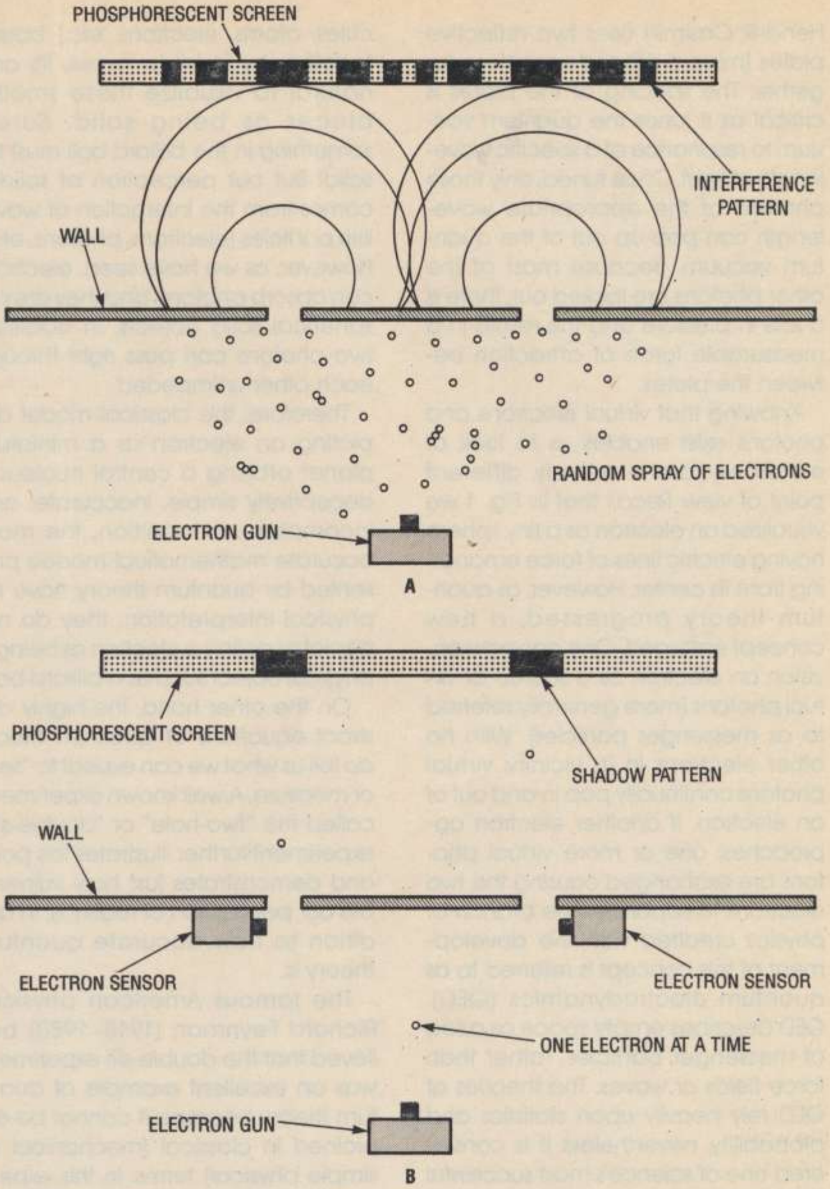


Fig. 7. The interference pattern resulting from electrons randomly sprayed through two slits in a wall can be viewed on a phosphor-coated screen (A), even if you only emit electrons one at a time; that is until you try to detect their position (B).

To Be, or Not to Be Negative-energy electrons are just like positive-energy electrons, except that they do not have enough energy to become a visible part of our physical world. However, according to Heisenberg, uncertainty is an inherent part of the microscopic world of atoms. Using Heisenberg's Uncertainty Principle, it is possible to imagine that any particle, including electrons and photons, can appear out of nowhere and then just as quickly disappear into the quantum vacuum. Provided the particle does not stay around more that a very brief instant the probability of such an event is very real. Physicists refer to these mysterious entities as virtual particles. In fact, empty space is a sea of all types of virtual particles.

A variety of experiments have been successfully performed in the laboratory that measure the effects of virtual particles. For example, the Casimir effect (named after its inventor

Hendrik Casimir) uses two reflective plates (mirrors) placed very close together. The spacing of the plates is critical as it tunes the quantum vacuum to resonance at a specific wavelength of light. Once tuned, only those photons of the appropriate wavelength can pop up out of the quantum vacuum. Because most of the other photons are locked out, there is a loss in pressure and this results in a measurable force of attraction between the plates.

Knowing that virtual electrons and photons exist enables us to look at electrons from a entirely different point of view. Recall that in Fig. 1 we visualized an electron as a tiny sphere having electric lines of force emanating from its center. However, as quantum theory progressed, a new concept emerged. One can now envision an electron as a source of virtual photons (more generally referred to as messenger particles). With no other electrons in its vicinity, virtual photons continually pop in and out of an electron. If another electron approaches, one or more virtual photons are exchanged causing the two electrons to separate. The branch of physics credited with the development of this concept is referred to as quantum electrodynamics (QED). QED describes empty space as a sea of messenger particles, rather than force fields or waves. The theories of QED rely heavily upon statistics and probability, nevertheless it is considered one of science's most successful propositions.

Going Further. Using particle accelerators, physicists are able to analyze the interior structure of many of the subatomic particles known today. With the particle accelerators presently available, details as small as 10^{-16} cm are discernible. However, even at that resolution, no internal structure can be detected in an electron! That is, they appear to be a point source of charge with no geometric extension and no internal parts.

With all of the forgoing in mind, we can now speculate about the nature of electrons, photons, and our perception of the world in general. Let's use a billiard ball as an example. Your first impression is that the billiard ball is a solid object. Even if you visualize it as a collection of smaller pieces (molecules, atoms, electrons, etc.) bound together by invisible forces, it's only natural to visualize these smaller pieces as being solid. Surely *something* in the billiard ball must be solid! But our perception of solidity comes from the interaction of wave-like particles (electrons, photons, etc.). However, as we have seen, electrons can absorb photons, and they are not spherical solid objects. In addition, two photons can pass right through each other unimpeded.

Therefore, the classical model depicting an electron as a miniature planet orbiting a central nucleus is deceptively simple, inaccurate, and incomplete. In addition, the more accurate mathematical models presented by quantum theory have no physical interpretation: they do not depict or define a electron as being a physical object such as a billiard ball.

On the other hand, the highly abstract equations of quantum theory *do* tell us what we can expect to "see" or measure. A well known experiment, called the "two-hole" or "double-slit" experiment further illustrates this point and demonstrates just how vulnerable our perception of reality is, in addition to how accurate quantum theory is.

The famous American physicist Richard Feynman (1918–1988) believed that the double-slit experiment was an excellent example of quantum theory because it cannot be explained in classical (mechanical or simple physical) terms. In this experiment (which can be done with electrons or photons), two holes are cut into a wall that separates a source of electrons from a phosphorescent (electron-detection) screen. Wherever an electron hits the screen, a bright spot appears. Assuming that electrons behave like waves, it is not difficult to imagine how two electron waves could mix together to generate a pattern of interference fringes on the detector screen. This is shown graphically in Fig. 7A. Using quantum theory, the probability of an electron hitting any given place on the detector screen is given by the square of the sum of the two individual wave functions. Thus, when you superimpose the two wave functions together they form an interference pattern.

If we cover up one of the holes, then as you would expect, a large spot without interference fringes is produced. In this case, the probability of an electron hitting any given place on the detector screen is given by the square of a single wave function.

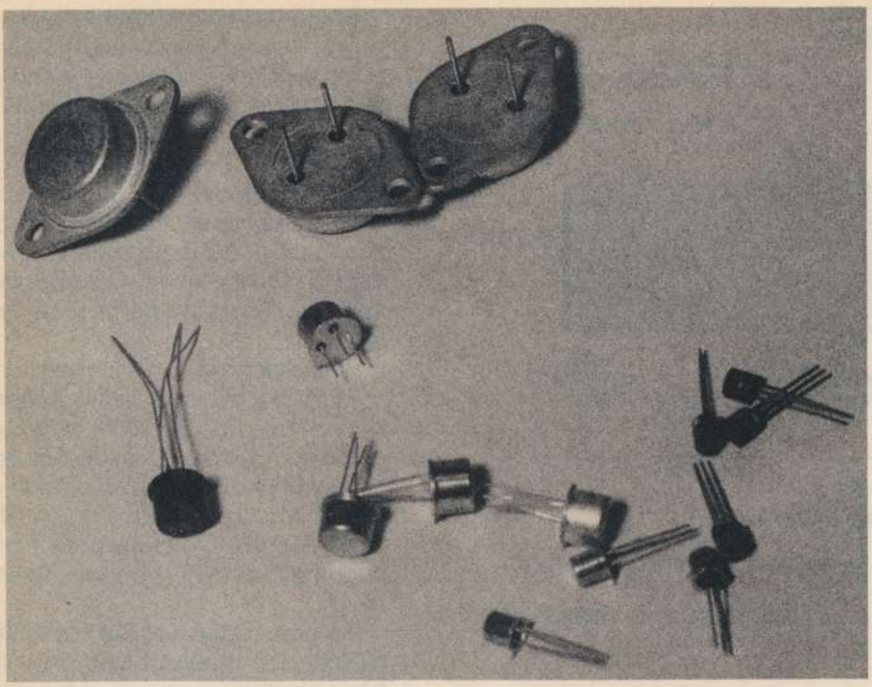
Now the strange part: let's say we open both holes, but adjust our electron source so that it emits just one electron at a time. Since only one electron passes through one hole at any given time, we should not expect to see the interference pattern characteristic of a two-hole experiment. Instead, we would expect each hole to allow a single large spot to form on the detector screen. Nevertheless, the interference pattern appears! It is as though each electron knows that there are two holes in the wall! The quantum wave function predicts this unreasonable result.

But wait, there is more! As shown in Fig. 7B, we can repeat the two-hole version of the experiment, but this time monitoring each hole with a sensitive detector. Whenever an electron passes through a hole, one of the detectors will beep to alert us. Oddly enough, the interference pattern is no longer produced. You might say that the electron knows we are watching! By observing the particle characteristic of each electron, we have in a sense "destroyed" its wave characteristics! The wave probability of each electron was collapsed the instant our detector pointed out the location of the electron particle.

The deceptiveness of our world is similar to watching a baseball game on television. If you stop to think about it, you'll realize that the picture is merely a facsimile of a real event occurring somewhere else. After all, you are just starring at a screen that generates a complicated pattern of light, but you do not consciously think of it in that way. Instead you become involved in the game, not on how its television image is being generated. In a similar, but much more subtle way, wave-like particles play an essential role in generating our physical world (or physical reality); but they are not made of anything solid!

The postulates of Einstein's Special Relativity also make this deception apparent, but from a slightly different perspective. They state that the laws of physics must be the same everywhere in the universe, regardless of an

(Continued on page 91)



All About Transistors: Bipolar Basics

BY ROBERT A. YOUNG

We look at the tiny devices that have reshaped the world of electronics.

Along with the solid-state diode, the point-contact transistor—invented in 1947 at Bell Labs—started the semiconductor revolution and has gone on to become one of the rudimentary devices in today's electronic equipment. The transistor, whether in discrete or IC form, is at the heart of most modern circuitry. Therefore, understanding how transistors function will help you properly design circuits containing them, and in case of a failure, enable you to find and correct the problem.

Bipolar-Transistor Composition. A bipolar transistor is basically two PN junctions connected back-to-back within the same piece of semiconductor material and sharing a common P- or N-doped semiconductor region. There are two types of bipolar transistor, the NPN and the PNP. Figure 1A is a simplified illustration of the composition of the NPN type of transistor. In our illustration, the NPN type unit is shown as P-doped semiconductor material sandwiched between two layers of N-doped material. The composition of a PNP transistor is just the opposite of that, (*i.e.*, the N- and P-doped materials in the transistor are interchanged). It follows then that biasing considerations for NPN units are also opposite from those for the PNP unit.

Note from Fig. 1A that a bipolar transistor is comprised of a center region called the base surrounded by two other regions known as the collector and the emitter. The difference between them will be discussed shortly. The two junctions are arranged so that they are very close together; that's done by making the shared base region very thin and lightly doped. That causes the two junctions to interact with one another. Conduction in the collector-base junction depends largely on what happens in the emitter-base junction.

Because the base region is lightly doped, it has a relatively small number of free carriers (holes in a P-type base and electrons in an N-type base) to conduct current. On the other hand, the emitter region is quite heavily doped, containing a much larger amount of donor impurity (for the NPN type) or acceptor impurity (for the PNP type), so there are many more free carriers available in the emitter region to conduct current than in the adjacent base region. Because of that, the emitter-base junction, when forward biased, conducts much the same as a common PN-junction diode.

The current that flows (composed of electrons for NPN units and holes, in the case of PNP transistors) is mainly from the emitter to the base rather than vice versa. That is where the emitter derives its name—it emits or injects current carriers into the other regions of the device.

The third region of a transistor, the collector, is lightly doped, much the same as the base, except with the opposite type of doping impurity, so it (like the base region) has relatively few free carriers available to conduct current in the normal way. The collector-base junction is normally reverse biased, so a depletion layer forms, spreading out on either side of the junction. The depletion layer effectively removes the carriers that would otherwise balance out the charges on the fixed impurity atoms of the crystals, setting up a potential barrier to match the applied reverse voltage.

To the normal majority carriers in the base and emitter, that potential barrier is a big wall that must be overcome before they can pass to the other side. So just as in the case of a normal diode, virtually no current flows across the collector-base junction when left to its own devices. However, the junction is not left to its own devices.

Remember that the base region is deliberately made very thin and lightly doped, while the emitter is made much more heavily doped. Because of that, applying a forward bias to the emitter-base junction causes majority carriers to be injected into the base, and straight into the reverse-biased collector-base junction.

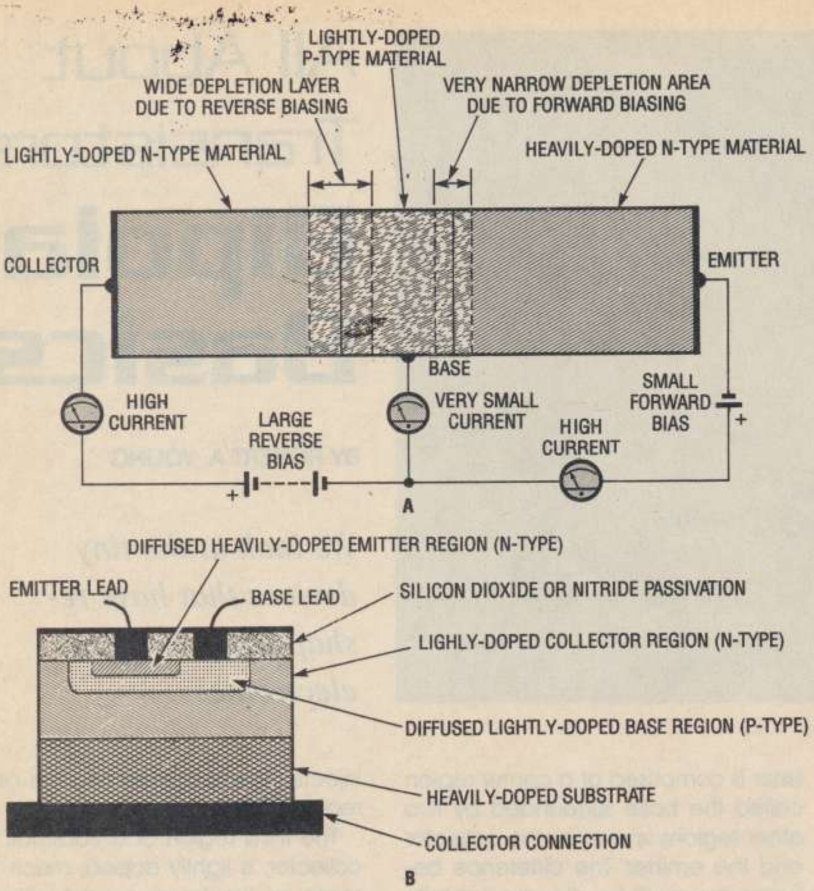

LIGHTLY-DOPED P-TYPE MATERIAL
WIDE DEPLETION LAYER DUE TO REVERSE BIASING
VERY NARROW DEPLETION AREA DUE TO FORWARD BIASING
LIGHTLY-DOPED N-TYPE MATERIAL
HEAVILY-DOPED N-TYPE MATERIAL
COLLECTOR
EMITTER
BASE
HIGH CURRENT
LARGE REVERSE BIAS
VERY SMALL CURRENT
HIGH CURRENT
SMALL FORWARD BIAS
+
+
A
DIFFUSED HEAVILY-DOPED EMITTER REGION (N-TYPE)
EMITTER LEAD
BASE LEAD
SILICON DIOXIDE OR NITRIDE PASSIVATION
LIGHLY-DOPED COLLECTOR REGION (N-TYPE)
DIFFUSED LIGHTLY-DOPED BASE REGION (P-TYPE)
HEAVILY-DOPED SUBSTRATE
COLLECTOR CONNECTION
B

Fig. 1. Shown in A is a simplified illustration of the composition of the NPN type of transistor, consisting of a layer of P-doped semiconductor material sandwiched between two layers of N-doped material. The actual form of the modern planar double-defused epitaxial junction transistor is shown in B.

Those carriers are actually minority carriers in the base region, because that region is of opposite semiconductor type to the emitter. To those majority-turned-minority carriers, the collector-base junction depletion region is not a barrier at all but an inviting, accelerating field; so as soon as they reach the depletion layer, they are immediately swept into the collector region.

Forward biasing the emitter-base junction causes two things to happen that might seem surprising at first: Only a relatively small current actually flows between the emitter and the base, much smaller than would flow in a normal PN diode despite the forward bias applied to the junction between them. A much larger current instead flows directly between the emitter and collector regions, in this case, despite the fact that the collector-base junction is reversed biased.

That effect is illustrated in Fig. 1A, which (hopefully) will help you to understand what is going on. The diagram shows a NPN transistor, but the action in a PNP unit is similar except for the opposite region polarity and conduction mainly by holes rather than electrons.

From a practical point of view, the behavior of bipolar transistors means that, unlike the simple PN-junction diode, it is capable of amplification. In effect, a small input current made to flow between the base and emitter results in a much larger output current flowing between the emitter and collector. Only a small voltage—around 0.6 volts for a typical silicon transistor—is needed to produce the small input current required.

In contrast, the reverse-bias voltage applied across the collector-base junction can be much larger; typically anywhere from 6 to 90 volts or more. So in producing and being able to control a larger current in this much-higher-output circuit, the transistor's small input current and voltage can achieve considerable voltage, power, and current, gains.

Bipolar transistors, therefore, work very well as both amplifiers and electronic switches. That is why they have become the workhorses of modern electronics, virtually replacing the vacuum tube. The diagram in Fig. 1A is designed to show how a bipolar transistor works, rather than its physical construction. The actual form of the modern, planar, double-defused epitaxial-junction transistor is shown in Fig. 1B.

The collector region is formed from a lightly doped layer grown epitaxially on the main substrate, which is made from the same type (but more-heavily doped) material to provide a low resistance connection. Here, both are N-doped material; for a PNP transistor, they would be P-doped material.

The base region is formed by lightly diffusing the opposite type impurity into a medium-sized area of the chip surface to reverse that type of area and create the base-collector junction. The emitter region is formed by making a second and heavier diffusion over the smaller area inside the first, but this time with the same kind of impurity as used for the epitaxial collector region.

The second diffusion is very carefully controlled so that the emitter region that results extends almost—but not quite—to the bottom of the base. That leaves the area of the base right below the emitter quite thin to ensure that as many as possible of the carriers injected from the emitter region will be swept through to the collector. The thinner that active base region, the higher (in general) the gain of the transistor.

Note that although the collector and emitter regions are made of the same type of semiconductor material, the two are physically quite different. The emitter is heavily doped (for good carrier injection) and can be relatively small since the emitter-base junction does not need to dissipate much power (heat). In contrast, the collector is lightly doped (for a wide depletion area) and its junction is much larger since, being reversed biased, it must dissipate much more power.

Connections to the emitter and base regions are made by way of aluminum electrodes deposited on the surface. Tiny wires are bonded to the electrodes for connection to the main device leads. The low-resistance substrate itself is used to connect to the collector region.

That is the basic construction used for most modern bipolar transistors, whether they are discrete units or part of an IC containing thousands of transistors. The main difference is size, although, in an IC, the collector region of the transistor will generally be in an epitaxial layer grown on the opposite kind of substrate, and separated by diffused walls (of the opposite type material) to separate the transistors from each other.

Inside an IC, the active part of an individual transistor might only be a couple of micrometers square, while a very large transistor (one used to switch hundreds of amperes) might be on a single wafer of 10 mm or more in diameter. Typical small-to-medium power, discrete transistors used in consumer and hobby electronics are grown on chips measuring from 1- to about 3-mm square—the rest of the component is protective packaging.

Transistor Operation. Refer to Fig. 2, a PNP version of the illustration shown in Fig. 1A. Note that both are essentially the same, except that in this instance, the collector is more negative than the base or the emitter. That is an important characteristic to remember when it comes to the operation of bipolar transistors.

If a positive voltage is applied to the P-doped emitter (to the left), current will be swept through the base-emitter junction—with the holes from the P-doped material moving to the right and the electrons from the N-doped material moving to the left. Some of the holes moving into the N-doped base region will combine with electrons and become neutralized, while others will migrate to the base-collector junction.

Normally, if the base-collector junction is negatively biased, there would be no current flow in the circuit. However, there would be additional holes in the junction to travel to the base-collector junction, and electrons can then travel toward the base-emitter junction, so a current flows even though that section of the sandwich is biased (at cutoff) to prevent conduction. Most of the current travels between the emitter and collector and does not flow out through the base.

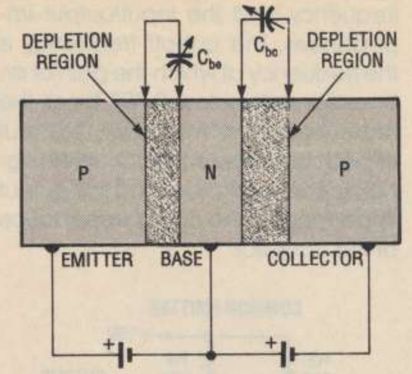


Fig. 2. Shown here is a PNP version of the illustration shown in Fig. 1A. Note that both are essentially the same, except that in this instance, the collector is now more negative than the base or the emitter.

The amplitude of the collector current depends principally on the magnitude of emitter current (*e.g.*, the collector current is controlled by emitter current). Note that between each PN junction, there is an area known as the depletion or transition region that is similar in some characteristics to a dielectric layer. That layer varies in accordance with the operating voltage. The semiconductor materials on either side of the depletion regions constitute the plates of a capacitor. The base-collector capacitance is indicated in Fig. 2 as C_{bc}, and the base-emitter capacitance is designated C_{be}. A change in signal and operating voltages causes a non-linear change in those junction capacitances.

There is also a base-emitter resistance (R_{be}) that must be considered. In practical transistors, emitter resistance is on the order of a few ohms, while the collector resistance is many hundreds or even thousands of times larger. The junction capacitance in combination with the base-emitter resistance determines the useful upper-frequency limit of a transistor by establishing an RC time constant.

Because the collector is reversed biased, the collector-to-base resistance is high. On the other hand, the emitter and collector currents are substantially equal, so the power in the collector circuit is larger than the power in the emitter circuit. ($P = I^2R$, so the powers are proportional to the respective resistances, if the currents are the same.) In practical transistors, emitter resistance is on the order of a few ohms, while the collector resistance is many hundreds or thousands of times larger, so power gains of 20 to 40 dB, or even more, are possible.

Figure 3 shows the schematic symbols for both the NPN and PNP versions of the bipolar transistor. The first two letters of the designations (NPN or PNP) indicate the polarities of the voltages applied to the collector and emitter in normal operation. For example, in a PNP unit, the emitter is made more positive with respect to the collector and the base, and the collector is made more negative with respective to the base. Another way of saying that is: the collector is more negative than the base and the base is more negative than the emitter.

Transistor Amplifiers. Transistors are among the most commonly used building blocks in electronics. While they can be used as electronically controlled switches, they are widely configured for amplifier use. In fact, the vast majority of electronic circuits contain one or more amplifiers of some type or another.

However, what exactly do we mean by the term amplifier? By definition an amplifier is a circuit that draws power from a source other than the input signal and produces an output that is usually an enlarged reproduction of the input signal.

We say usually because not all amplifiers are used to magnify the input signal—buffer amplifiers (often called unity-gain amplifiers) are not designed to magnify the input signal. When operated as a buffer, the transistor is used to isolate one stage from the effects of one that follows. Since buffer amplifiers provide no increase in signal level, a 10-millivolt (mV) signal

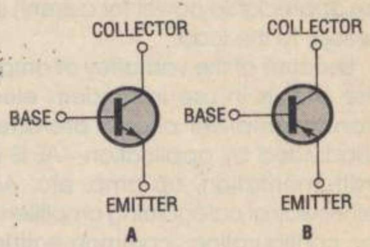


Fig. 3. The schematic symbol for the NPN bipolar transistor is shown in A, while its PNP counterpart is shown in B.

TABLE 1—AMPLIFIER CONDUCTION ANGLES & EFFICIENCY

Class	Angle (Degrees)	Effiency %
A	360	20 – 25
B	180	60 – 78.5
AD	180 – 360	25 – 78.5
C	<180	>78.5

applied to the input of a unity-gain amplifier produces an output signal at the same 10-mV level (a carbon copy of the input signal).

There are many types of amplifiers, however, and all fall into one of two broad categories: voltage amplifiers or current (often referred to as a power) amplifiers. The term voltage amplifier applies to a circuit in which a low voltage is applied to the input to produce a higher voltage at the output. The term power amplifier is generally reserved for those that supply an appreciable power (or current) increase to the load.

Because of the vast array of amplifier circuits in use in modern electronics, amplifier circuits are often subdivided by application—AF, IF, RF, instrumentation, op-amp, etc. Another way of categorizing amplifiers is by configuration: common-emitter, common-collector, and common-base, for example. The important parameters in such circuits are the cutoff frequency and the input/output impedances. The cut-off frequency is the frequency at which the gain of an amplifier falls below 0.707 times the maximum gain of the circuit. The input impedance is the impedance the signal source would see, and the output impedance is the output impedance of the transistor.

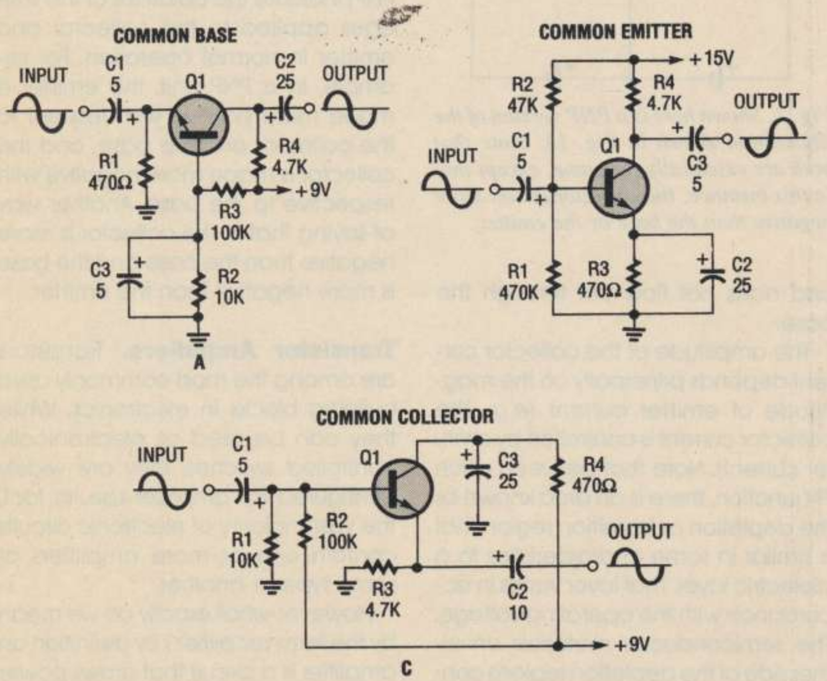


Fig. 4. Examples of the common-base, common-emitter, and common-collector amplifiers are shown in A, B, and C, respectively.

Amplifier Configurations. An example of a common-base amplifier is shown in Fig. 4A. The optimum load impedance can range from a few thousand ohms to 100,000 ohms, depending on the circuit's requirements. In this type of circuit, the output signal (at the collector) is in phase with the input signal (applied to the emitter). The current that flows through the base resistance of the transistor is therefore in phase as well, so the circuit tends to be regenerative and will oscillate if the current-amplification factor is greater than one.

A common-emitter (also called a "grounded-emitter") amplifier is shown in Fig. 4B. Base current in this amplifier configuration is small and the input impedance is therefore fairly high (several thousand ohms on the average). Collector resistance on the other hand, can be tens of thousands of ohms, depending on the signal's source impedance. The common-emitter amplifier has a lower cutoff frequency than does the common-base type, but gives the highest power gain of the three configurations. Note that the output signal is 180° out-of-phase with (or the opposite of) the input (base-current) signal, so the feedback that flows through the small emitter resistance is negative (degenerative), keeping the circuit stable. The common-emitter amplifier is one of the most often seen configurations for the bipolar transistor.

The common-collector amplifier (also referred to as an emitter follower), see Fig. 4C, has a high input impedance and a low output impedance. The impedance is approximately:

$$R_s \times (1 - \alpha)$$

The fact that the input resistance is directly related to the load resistance is a disadvantage of this type of amplifier if the load is one whose resistance or impedance varies with frequency. The current transfer ratio of this type of circuit is:

$$1 / (1 - \alpha)$$

and the cutoff frequency is the same as in the common-emitter amplifier circuit. The output and input currents of this type of circuit are in phase.

Amplifier Classifications. Amplifiers may be otherwise classified by their specific operational characteristics, in particular, the bias voltages between the emitter-base and base-collector junctions. The relationship between the bias voltage and the cutoff voltage of an amplifier is what classifies an amplifier as being class A, B, C, or AB. Each class has a specific characteristic that makes it most suitable for a particular application.

In a class-A amplifier—which is the least efficient, but offers the least distortion—the transistor is biased so that its quiescent operating point is in the midddle of the power-supply extremes, *i.e.*, the transistor is always turned on, and the resulting output varies around the bias voltage; see the output waveform in Fig. 5A. Because of that, the input signal must be small enough so that its positive and negative swings do not drive the amplifier near the non-linear cutoff and saturation regions.

(Continued on page 88)

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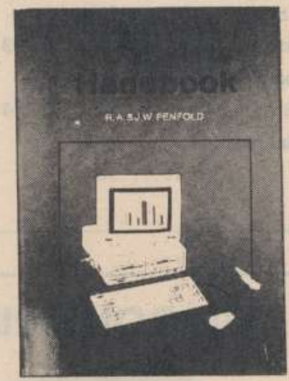

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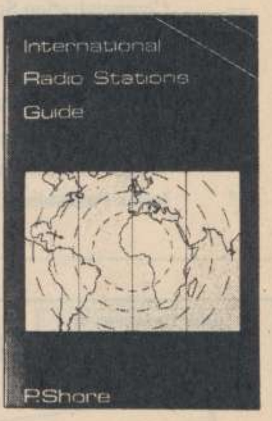

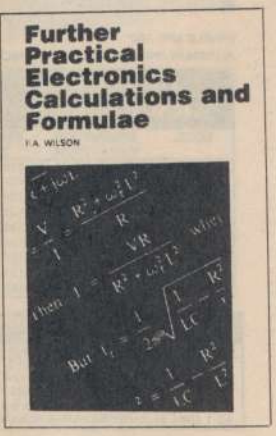

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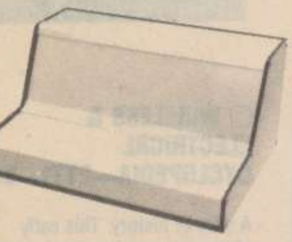

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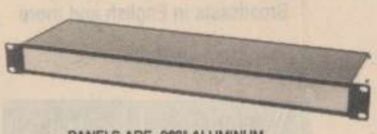

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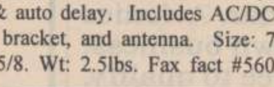

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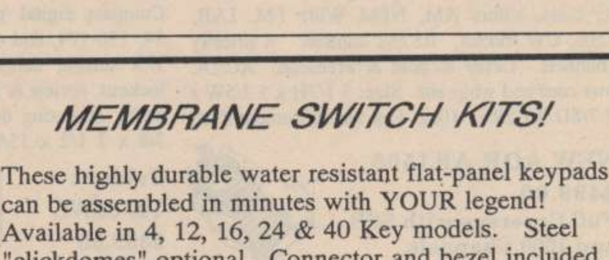

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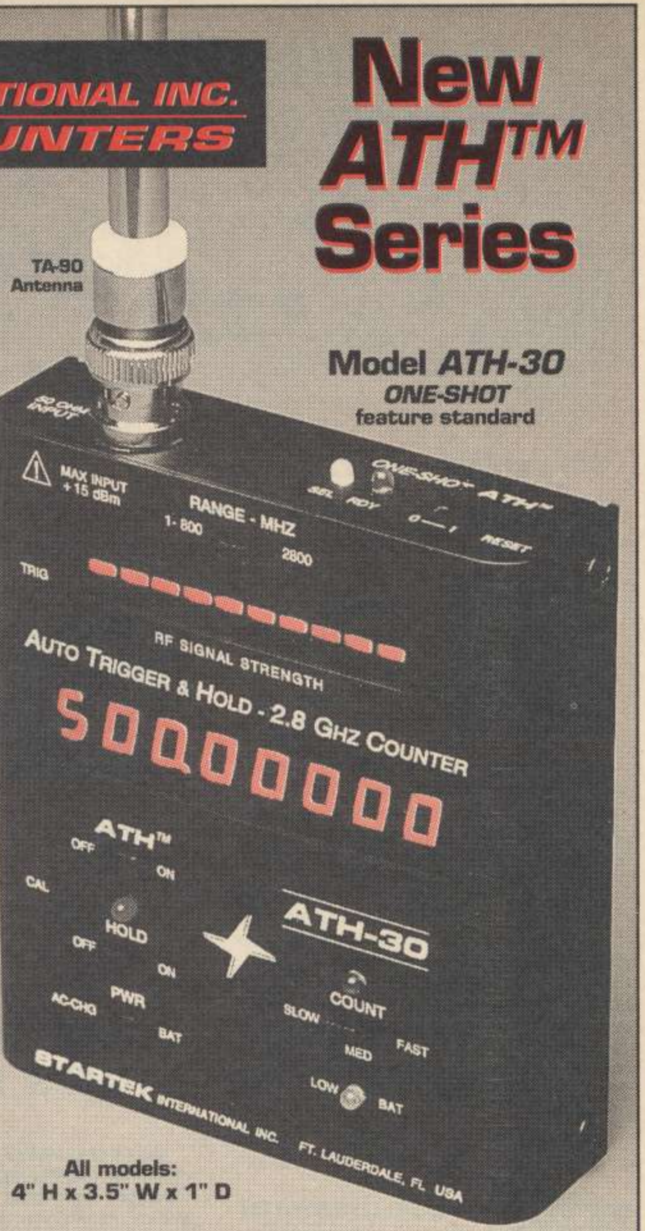
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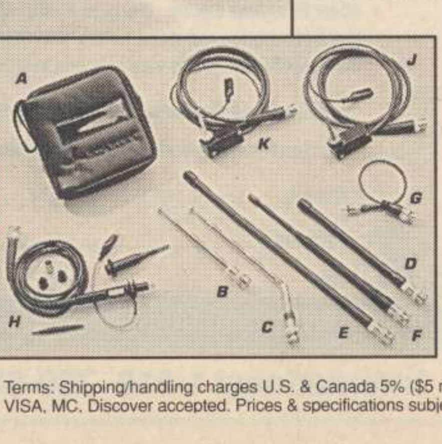
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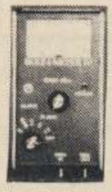

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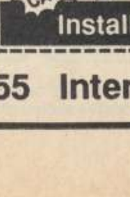

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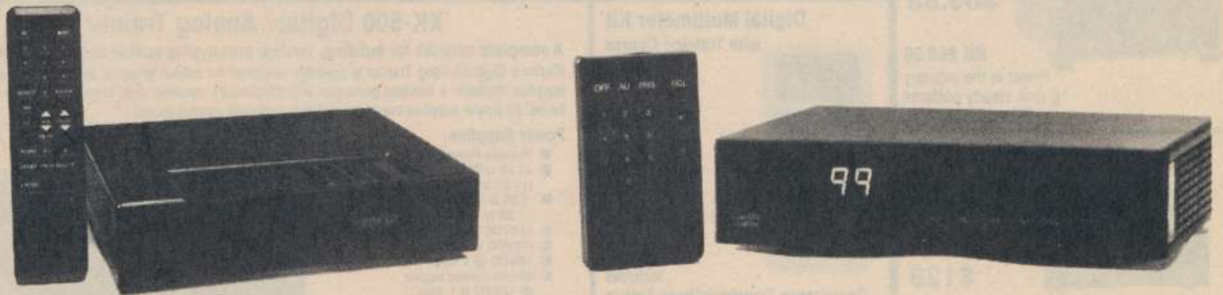

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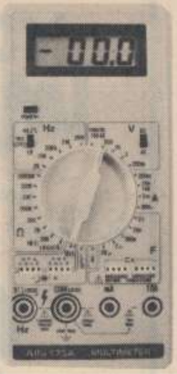

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Fluke 73 II	$90
Fluke 75 II	$127
Holster C-70	$15
Fluke 77 II	$147
Fluke 79 II	$167
Fluke 29 II	$167
Fluke 83	$225
Fluke 85	$259
Fluke 87 True RMS	$285

Fluke 97 Scope Meter $1750

LCR Meter 814 $199.95

The Best Handheld LCR

Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Best for high frequency RF and surface mount components.
SMD and chip component test probe $25.00, Deluxe carrying case $5.00

LCR Meter 195 $119.95

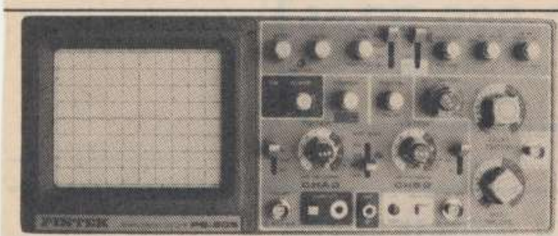
Very Popular LCR

Inductance: 1µH-200H
Capacitance:0.1pF-200 µF
Resistance:0.01Ω-20MΩ
Basic accuracy:R:1%, C:2%, L:3%
Test frequency 1 kHz
Soft carrying case $3.00
Deluxe case $5.00

Capacitance Meter 7705 $57.95

0.1 pF-20,000µF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate parasitics from test fixture

Also Available:
Heavy duty DMM, AC/DC clamp meter, Thermometer, Light meter pH meter,, High voltage probe Digital caliper, Anemometer Elctronic scale, Force guage Tachometer, Humidity & EMF adapter, Sound level meter Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
PS-605 60 MHz DELAY SWEEP	$769.95

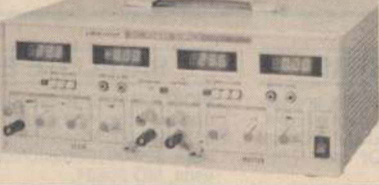
20 MHz Digital Storage Oscilloscope DS-203 $729.95

Switchable between digital and analog modes
2 K word per channel storage
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter Control

DC Power Supply PS-303 $159.00

0-30 VDC , 0-3A output

0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A



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Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected

Also available: 30V/5A	triple output	$549.95
60V/5A	dual tracking	$749.95

RF SIGNAL GENERATOR SG-4160B $119.00

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

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Generates signal same as FG-2100A
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Feature TTL and CMOS output

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Kit $49.95

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10 rock steady patterns
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RF Freq 100K-450MHz AM Modulation of 1KHz Variable RF output
SG-9500 w/ Digital Display & 150MHz built-in counter $239

Sweep/Function Generator with Freq. Counter

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Measures Frequency, Period, Totalizer
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Elenco's Digital/Analog Trainer is specially designed for school projects, with 5 built-in power supplies. Includes a function generator with continously variable, sine, triangular, square wave forms. All power supplies are regulated and protected against shorts.

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- Variable Power Supply
- +1.25 to 20VDC @ .5 Amp (+1.25 to 15VDC @ 1 Amp)
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- -12VDC @ 1 Amp
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- 30VAC Center tapped @ 15VAC at 1 Amp

Analog - Section
- Function Generator Sine, Triangular, Square wave forms
- Frequency adjustable in five ranges from 1 to 100KHz
- Fine frequency adjust
- Amplitude adjust
- DC offset
- Modulation FM-AM

Digital - Section
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- Two no bounce logic switches
- 8 LED readouts TTL buffered
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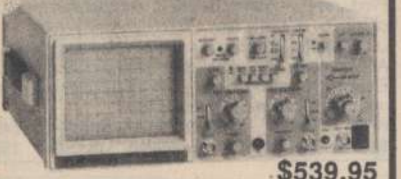

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- Dual time base
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- TV Sync

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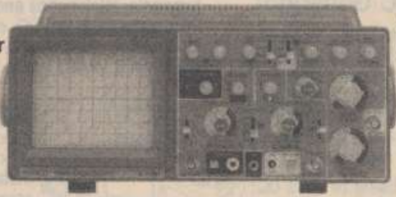
Dual Trace



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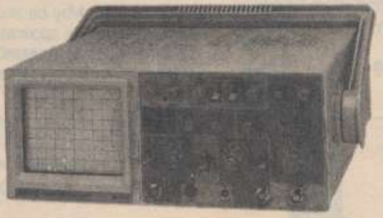

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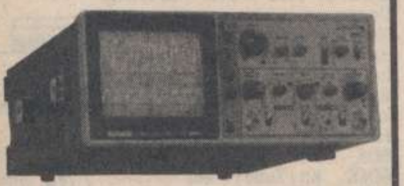

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Fluke 29 II	$167
Fluke 83	$225
Fluke 85	$259
Fluke 87 True RMS	$285
Fluke 97 Scope Meter	$1750

LCR Meter 814

$199.95

The Best Handheld LCR

Inductance: 0.1μH-200H
Capacitance: 0.1pF-20,000μF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Best for high frequency RF and surface mount components.
SMD and chip component test probe $25.00, Deluxe carrying case $5.00

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LCR Meter 195

$119.95

Very Popular LCR

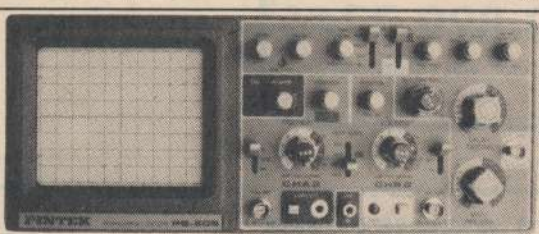
Inductance: 1μH-200H
Capacitance:0.1pF-200 μF
Resistance:0.01Ω-20MΩ
Basic accuracy:R:1%, C:2%, L:3%
Test frequency 1 kHz
Soft carrying case $3.00
Deluxe case $5.00

7705 CAPACITANCE METER

Capacitance Meter 7705 $57.95

0.1 pF-20,000μF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate parasitics from test fixture

Also Available:
Heavy duty DMM, AC/DC clamp meter, Thermometer, Light meter pH meter,, High voltage probe Digital caliper, Anemometer Elctronic scale, Force guage Tachometer, Humidity & EMF adapter, Sound level meter Frequency counter, SWR/field strength/power meter, Dip meter



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Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
PS-605 60 MHz DELAY SWEEP	$769.95

20 MHz Digital Storage Oscilloscope DS-203 $729.95

Switchable between digital and analog modes
2 K word per channel storage
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter Control

LODESTAR DC POWER SUPPLY

DC Power Supply PS-303 $159.00

0-30 VDC , 0-3A output

0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A

DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected

Also available: 30V/5A	triple output	$549.95
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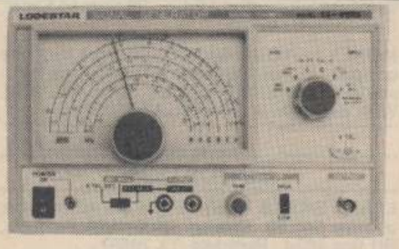

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100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
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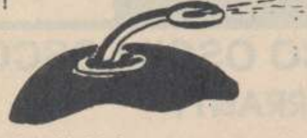
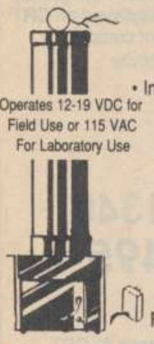
Mystery Levitating Device



Remember War of the Worlds? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

ANT1K Easy to Assemble Kit / Plans $19.50

Combination Solid State Tesla Coil & Variable 100,000VDC Generator



Operates 12-19 VDC for Field Use or 115 VAC For Laboratory Use

Experiments Using Tesla Coil:

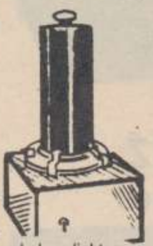
- Plasma in a Jar/Tornado, Furnace
- Kirlian Photography
- Wireless Energy Transmission
- Induction Fields
- Pyrotechnic Effects
- Corona and Brush Discharge
- Energizer for Neon Plasma Tubes

Experiments Using Hi Volts DC:

- Plasma Blaster Driller/Cutter
- Anti-Gravity/Force Fields
- Ion Reaction Motors
- Lightning Generation
- High Ion Source
- Ozone For Air Purification
- Electrification of People & Objects
- Particle Accelerators/Atom Smashing
- High Energy Capacity Charging

HVM7	**Plans Complete System**	**$15.00**
HVM7K	**Complete System Kit/Plans**	**$174.50**
TCL4K	**Tesla Coil Only Kit/Plans**	**$99.50**
115/19AC	**Wall Adapter for 115AC**	**$15.50**

Table Top Tesla Coil



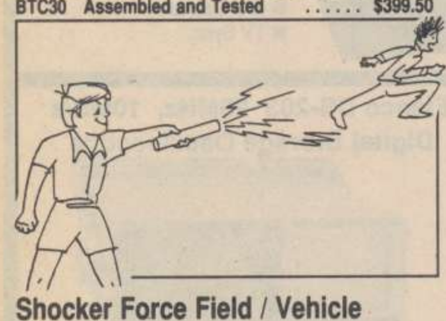
Spectacular - A Real Attention Getter!

• 250,000 Volts! • 7-10' Sparks! Energy even passes through windows. Great for science projects, displays, advertising.

Highly spectacular devices produces visible, audible bolts of lightning appearing to flash in the air. Causes certain materials to burn from within and glow, lights bulbs without wires, produces induction fields, St Elmo's fire corona. Clearly demonstrates high frequency high voltages yet terminal may be touched by user during operation with a metal object. 115VAC operation only.

BTC3 Plans .. $15.00 BTC3K Kit/Plans $299.50

BTC30 Assembled and Tested $399.50



Shocker Force Field / Vehicle Electrifier

- Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great pay back for those wise guys who have wronged you!

SHK1KM Easy To Assemble Electronic Kit . $24.50

High Voltage for the Hobbyist!

Experiment with the forces used in **hover boards, lasers, night vision, mini Tesla coils, plasma globes, magic shows, shock/stun devices, ion ray guns, anti-gravity, pyrotechnics, hypnosis, telekinetics and hundreds more.** Operates from batteries, 9-14 VDC, or 115VAC using adapter.

MINIMAX 4	**4,000 Volts, 5ma, 4.5x1.5x1"**	**$19.50**
MINIMAX 2	**2,000 Volts, 5ma, 3.5x7/8" dia**	**$14.50**

Ultrasonic Blaster

Laboratory source of acoustical shock waves. Blow holes in metal, produce "cold" steam, atomize liquids. Many cleaning uses for PC boards, jewelry, coins, small parts, etc.

ULB1 Plans ..... $10.00 ULB1K Kit/Plans $69.50

100,000V Intimidator / Shock Wand Module

Build an electrical device that is affective up to 20 feet. May be enclosed for handheld, portable field or laboratory applications.

ITM2KM Easy to Assemble Electronic Kit ... $49.50

ITM2 Plans Only; Credit-able to Kit $10.00

Ion Ray Gun

- Projects charged ions that induce shocks in people & objects without any connection! Great science project as well as a **high tech** party prank.

IOG3 Plans ..... $10.00 IOG3K Kit/Plans $69.50

Invisible Pain Field Generator

Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy capable of warding off aggressive animals, etc.

IPG7 Plans .... $8.00 IPG7K Kit / Plans $49.50

IPG70 Assembled $74.50

Homing / Tracking Transmitter

- Beeper device, 3 mile range.

HOD1 Plans .... $10.00 HOD1K Kit/Plans $49.50

Listen Thru Walls, Floors

Highly sensitive stethoscope mike.

STETH1 Plans ... $8.00 STETH1K Kit/Plans $44.50

3 Mile FM Wireless Mike

- *Subminiature!*

Crystal clear, ultra-sensitive pickup transmits voices and sounds to FM radio. Excellent security system, warns of intrusion. Become your neighborhood disk jockey! Monitor children and invalids.

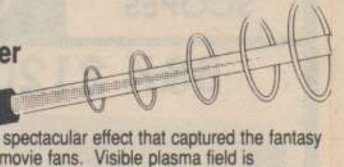
FMV1 Plans ..... $7.00 FMV1K Kit/Plans . $39.50

Telephone Transmitter - 3 Miles!

Automatically transmits both sides of a telephone conversation to an FM radio. • Tunable Frequency • Undetectable on Phone • Easy to Build & Use • Up to 3 Mile Range • Only transmits during phone use

VWPM7 Plans .... $7.00 VWPM7K Kit/Plans $39.50

Plasma Fire Saber



Produces the spectacular effect that captured the fantasy of millions of movie fans. Visible plasma field is controlled by grip pressure and adjusts saber length. Active energy field produces weird & bizarre effects. Excellent for special effects. Specify photon blue, neon red, phasor green, or starfire purple.

PFS2 Plans .... $8.00 PFS2K Kit/Plans $49.50

Special Offer PFS20 Assembled reg $89^{50}, **$59.50**

TV & FM Joker / Jammer

- Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required.

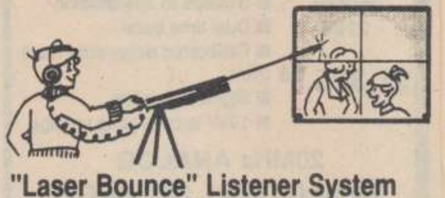
EJK1KM Easy to Assemble Electronic Kit $19.50

Visible Beam Laser

High brightness red HeNe laser visible for miles. **Produce your own light show!** Projects a beam or red lite clearly visible in most circumstances. Can be used to intimidate by projection of a red dot on target subject. Also may be used to "listen in" using our laser *window bounce* method #LLIS1 below. **Easy to Build Modules Makes A Working Visible Laser:**

LAS1KM Kit w/1mw Laser Tube, Class II . $69.50

LAS3KM Kit w/2.5mw Laser Tube, Class IIIA $99.50



"Laser Bounce" Listener System

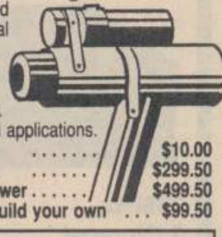
allows you to hear sounds from an area via a lite beam reflected from a window or other similar object. System uses our ready-to-use LATR1 Laser Terminator gun site as the transmitter. The receiver section is supplied as an easy-to-build kit, including our cushioned HS10 headsets. **Order # LLIST20 System, includes our LATR1 Ready-to-Use Laser Gun Site, LLR1K Special Receiver Kit, and HS10 Headset, all for only $299.50**

5mw Visible Red Pocket Laser

Utilizes our touch power control!

VRL3KMX Kit / Plans $119.50

See In The Dark Viewing



Device uses invisible infrared illumination for seeing in total darkness. Excellent for low cost night vision, along with observing lasers and other IR sources. Functional unit, many useful applications.

SD5	**Plans**	**$10.00**
SD5K	**Kit / Tube / Plans**	**$299.50**
GPV10	**Ready to Use Viewer**	**$499.50**
6032A	**Tube / Plans to build your own**	**$99.50**

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Most homes and offices have hot spots with strong artificial electro-magnetic fields, where chronic exposure may cause mental or physical problems. Even the EPA names these fields as suspected carcinogens. You can reduce your risk by avoiding these high-field areas.

The ***TriField***™ meter detects *far more* of these fields than any other electromagnetic pollution meter. It's the only one that independently reads AC electric fields, AC magnetic fields, *and* radio/microwaves. It also reads field strengths in *all directions simultaneously*. Every other meter that sells for under $500 reads only magnetic and only in one direction — they can entirely miss a magnetic field unless pointed correctly and are blind to radio/microwaves and electric fields, both of which cause biological effects.

The ***TriField***™ meter reads all three types of fields numerically and with a SAFE/BORDERLINE/HIGH SCALE, weighted proportional to effect on the body. Thresholds are based on epidemiological and laboratory studies. (While no *absolute* hazard thresholds have been established, reduction of *relative* exposure is prudent.)

The ***TriField***™ meter comes ready-to-use with battery, instructions, and one-year limited warranty. The cost is $144.50 postpaid.

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DPV-7212	CALL	MIKE
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SCIENTIFIC ATLANTA	**1-3**	**4 or more**
*NEW SA-3 COMBO (SA-3B)	130.00	125.00
NEW SA-3 PAN	75.00	60.00
8550:	175.00	165.00
8580:	250.00	CALL
8536:	210.00	205.00
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NEW OAK N-12 COMBO(Vari Sync)	130.00	125.00
NEW OAK N-12 PAN(Vari Sync)	75.00	60.00
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PANASONIC-VIEWSTAR	**20 LOT**	**100 LOT**
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ZENITH: Z-TAK	220.00	CALL
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* All Combos come with new Panasonic or Viewstar converter.
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Volume control units available

MOST ORDERS SHIPPED SAME DAY!

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TOTAL			

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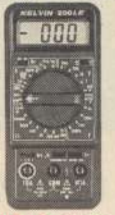

200 LE - *Technician*

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Standard Features - ● AC & DC VOLTAGES ● DC CURRENT ● RESISTANCE ● **TRANSISTOR** ● CONTINUITY TEST - Buzzer ● DIODE TEST ● 3 1/2 Digit LCD ● 10M ohm INPUT IMPEDANCE

150 LE	200 LE	400 LE
BATTERY TEST TRANSISTOR **DC CURRENT** **10 Amp**	**FREQ COUNTER** up to 20MHz **TRANSISTOR** **CAPACITANCE** from 1pF to 20uF **AC/DC CURRENT** **10 Amp**	**INDUCTANCE** Resolution 1uH **FREQ COUNTER** up to 20MHz **CAPACITANCE** from 1pF to 200uF **AC/DC CURRENT** **DUTY %** **20 Amp**
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Designed to meet IEC-348 & UL-1244 safety specifications

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The only meter with **0.1% Accuarcy** on DC Voltages, built-in **True RMS, Freq Counter to 20MHz** Res: 10 Hz, **LCR-Inductance Tester** Res: 10 uH, **DC/AC Voltages** Res:0.1mV, **Ohm Meter** Res: 0.1 ohms

TRUE RMS PLUS

Model 94
#990111
$199.95
**See Standard Features Listed below*

12 INSTRUMENTS IN ONE - **AC & DC VOLTMETERS, AC & DC CURRENT, dBm, OHMMETER, DIODE TESTER, AUDIBLE CONTINUITY TEST, 20MHz FREQ COUNTER, CAPACITANCE METER, INDUCTANCE METER, LOGIC PROBE**

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Model 95 #990112
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A Must For Auto Mechanics

Standard Features plus - TEMP, TACHOMETER & DWELL ANGLE TESTER, DUTY CYCLE, 10M OHM IMPEDANCE, ANALOG BAR GRAPH, K-TYPE TEMP PROBE, ALLIGATOR CLIP TEST LEADS, INDUCTIVE PICKUP CLIP, 6' TEST LEADS & DELUXE CARRYING CASE

*** *Standard Features* - Models 94 & 95**

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- OHM METER ● DATA HOLD ● RELATIVE MODE
- FREQ COUNTER to 4 MHz (Model 95)
- AUDIBLE CONTINUITY TEST ● DIODE TEST
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- AUTO SLEEP & AUTO POWER OFF

KELVIN
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- AC & DC VOLTAGES
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- RESISTANCE
- CONTINUITY TEST-Buzzer
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- DIODE TEST ● BATTERY TEST

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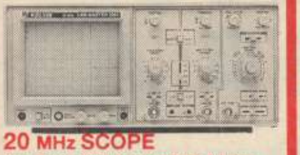
- RESISTANCE
- CONTINUITY TEST
- DIODE TEST 3 1/2 Digit LCD
- 10M ohm INPUT IMPEDANCE

INSTRUMENTS



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990105	RED	$.65 ea.	$.50 ea

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ORIGINAL DESIGN - 24 Hr. Binary Quartz Accurate Clock with 2 color LED's. Built-in **Alarm** and **Alarm Display** in binary code. **DESIGNED FOR LEARNING** *about digital circuitry & binary code.* Built with individual IC components. **Battery Memory Loss Prevention.** *Comes with rechargeable battery, DC wall transformer and* detailed instruction manual. **Advanced Level Kit**
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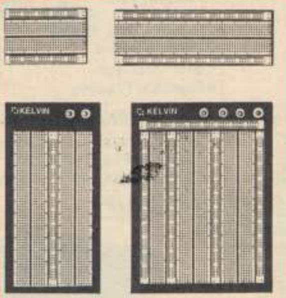

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680098	2	1380	$11.75
680100	4	2390	$22.96

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Pre-cut, Pre-Stripped
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600029	**556 DUAL TIMER**	$.40 ea
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600018	**741C OP-AMP** INTERNALLY COMPENSATED	$.30 ea
600026	**1458 OP-AMP** DUAL 741C OP-AMP	$.35 ea
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SILICON CONTROLLED RECTIFIER
(Similar to GE C106C1) 4.0 amp, 100PIV
600014 ..... $.89 ea .... $.79 ea/10+

THERMISTER - 100 ohm
110097 ..... $1.35 ea .... $1.00 ea/20+

THERMISTER - 10K ohm
110097 ..... $1.35 ea .... $1.00 ea/20+

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260027	GREEN	$.08 ea	$.07 ea
260026	YELLOW	$.08 ea	$.07 ea
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$2.95 ea / 20+ Qty

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V_{BR} 3.2V. V_F 250 mV @ 1 mA C_{JO} 0.1 pF nom. @ 0 V. R_D 12Ω typ. Usable to 20 GHz. Ideal for microwave mixers and other applications. Metelics #M2X1168. (93S018)

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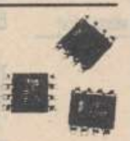

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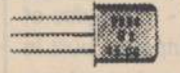

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- 16 levels of voice masking.
- Button for normal operation.
- Complete anonymity on all calls

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STOP THOSE ANNOYING PHONE CALLS! Sound older and tougher when you want to. Not a kit, fully assembled. Single line phone operation only.

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- Connects between handset and phone.
- 16 levels of voice masking

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- Transmits both sides of phone conversation.
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- Up to 1 mile range.
- Turns off when phone is not in use to extend battery life.

XTT100 LONG RANGE PHONE TRANSMITTER

Similar to our very popular XSP500, the XTT100 is battery powered for maximum range. It plugs into any phone jack and transmits all calls on that line.

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- Up to 1 mile range.
- Powered by 9V battery.

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68	0.031	**DRB-68**
67	0.032	**DRB-67**
66	0.033	**DRB-66**
65	0.035	**DRB-65**
63	0.037	**DRB-63**
61	0.039	**DRB-61**
59	0.041	**DRB-59**
58	0.043	**DRB-58**
57	0.045	**DRB-57**
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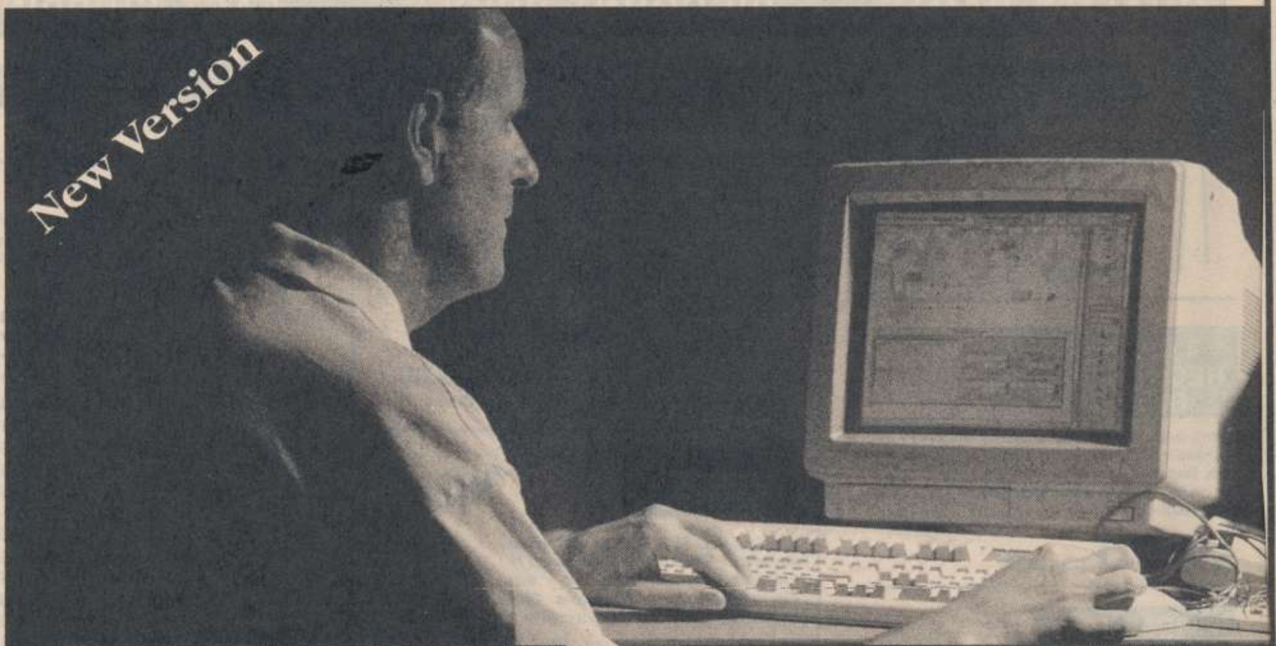
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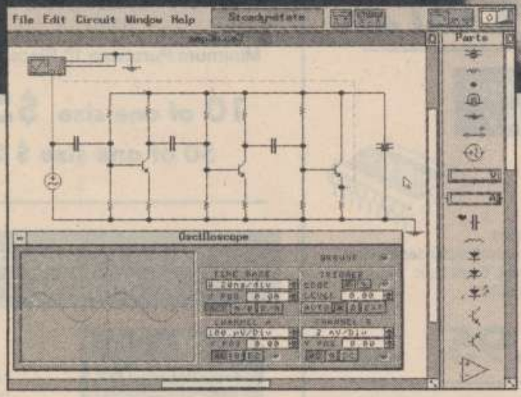
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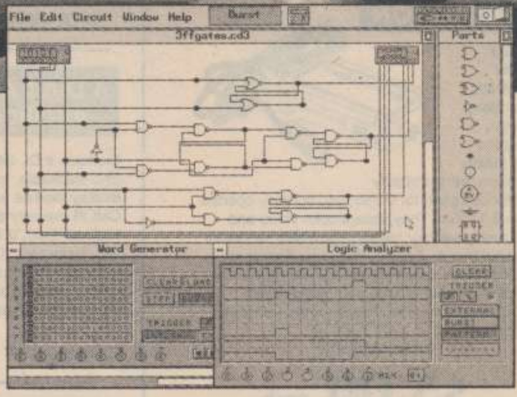
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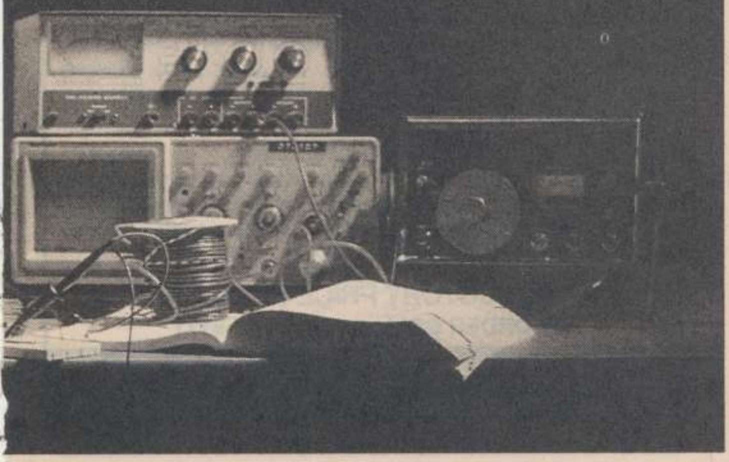

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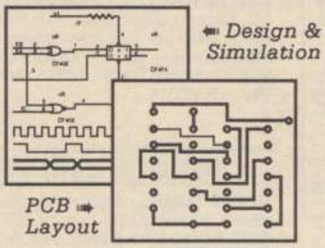

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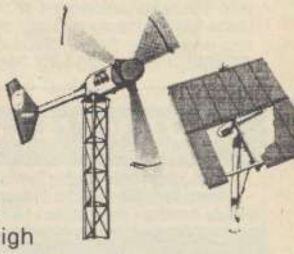

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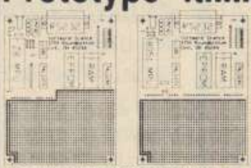

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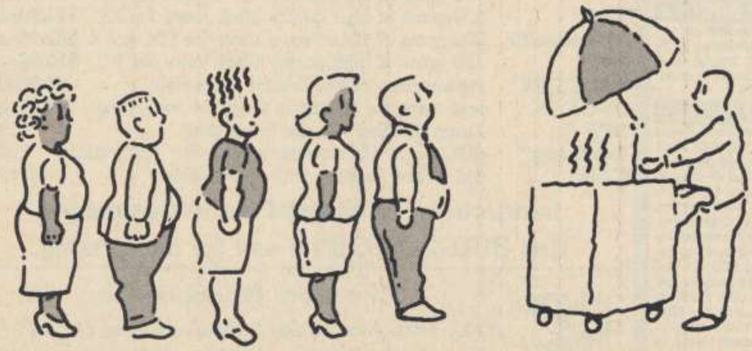

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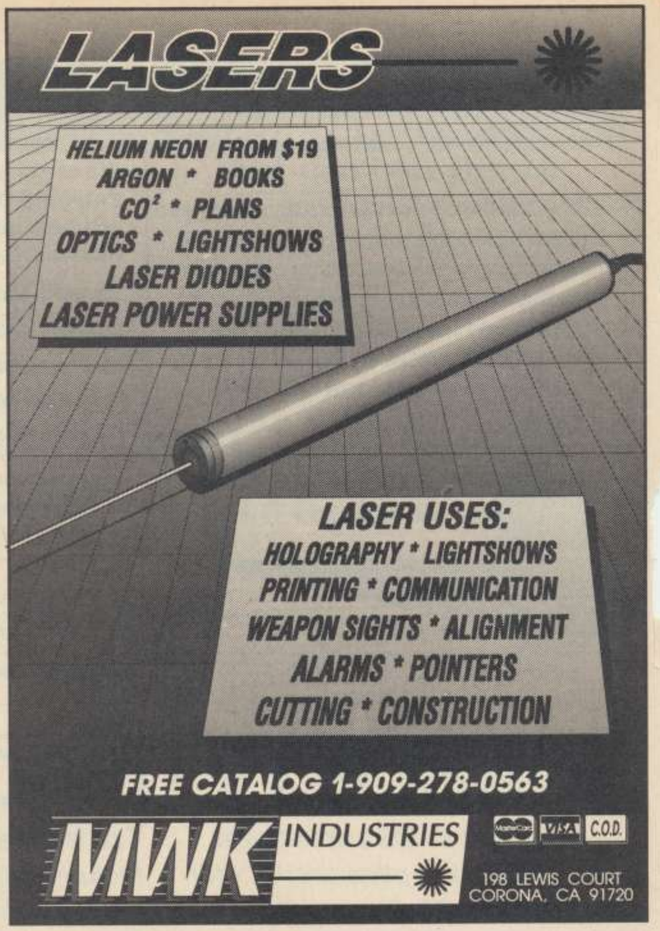

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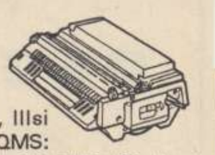

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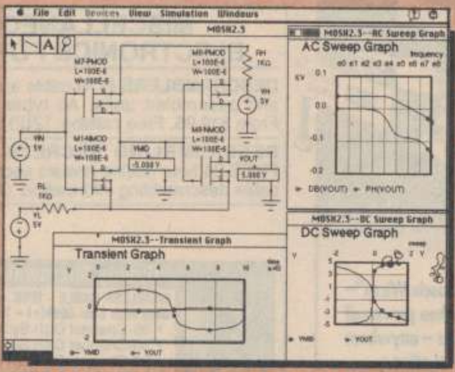
File Edit Devices View Simulation Windows
MOSH2.3
M7-PMOD L=100E-6 W=100E-6
M8-PMOD L=100E-6 W=100E-6
M14NMOD L=100E-6 W=100E-6
M9-NMOD L=100E-6 W=100E-6
RH 1KΩ
VH 5V
VIN 5V
RL 1KΩ
VL 5V
VMID -5.000 V
VOUT 5.000 V
MOSH2.3--AC Sweep Graph
AC Sweep Graph
frequency
DB(VOUT) PH(VOUT)
MOSH2.3--DC Sweep Graph
DC Sweep Graph
VMID VOUT
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Transient Graph
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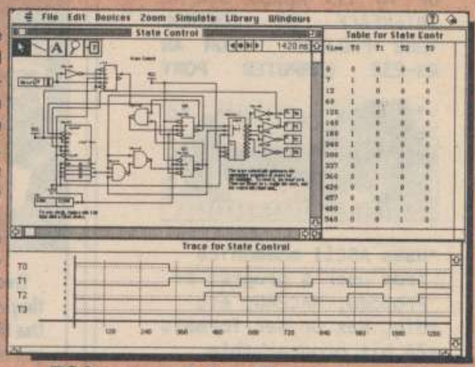
File Edit Devices Zoom Simulate Library Windows
State Control
1420 ns
Table for State Contr
Time T0 T1 T2 T3
Trace for State Control
T0
T1
T2
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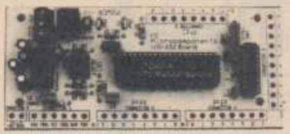

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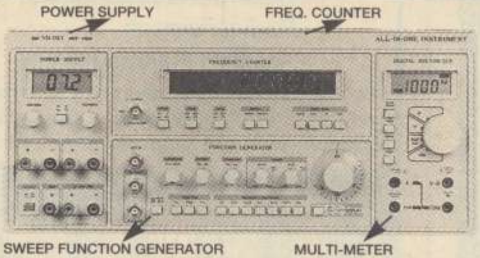

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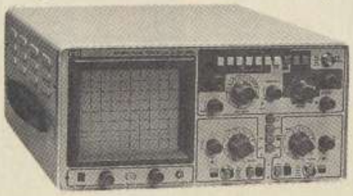

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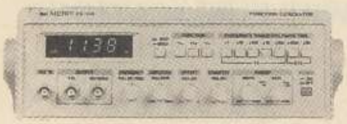

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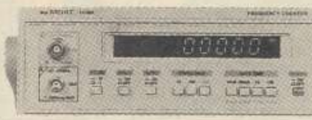

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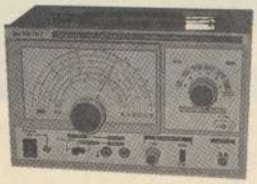

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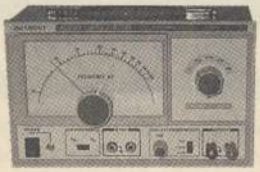

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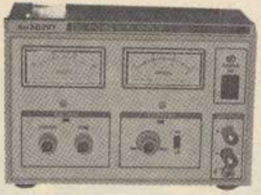

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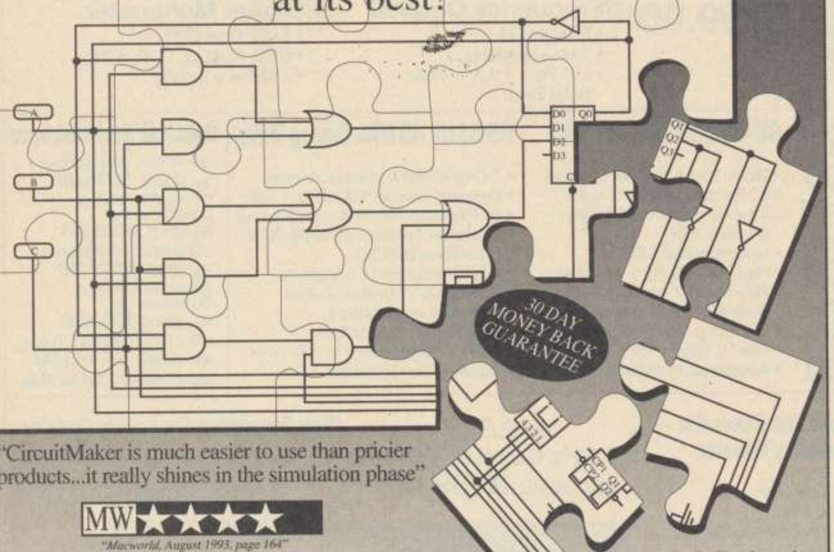

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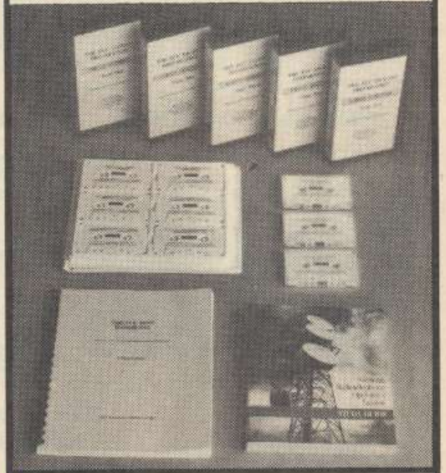

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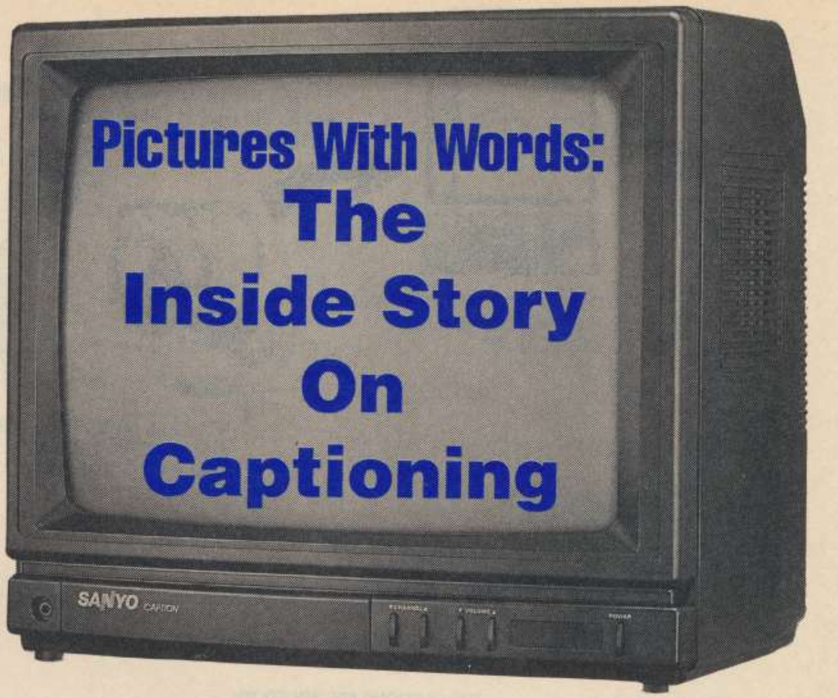


Pictures With Words: The Inside Story On Captioning

New TV receivers with a screen sizes of 13 inches or larger will include an additional feature: a caption-display mode.

BY ROBERT N. ANGUS

It might come as a suprise to most, but you'll probably be paying for something extra with your next TV purchase: a caption display. "But wait," you might say, "TV captioning is for the hard of hearing. I'm not deaf, and nobody in my household is, either. Why should I pay for a feature I'm not likely to use?" Because Congress says so according to the "Television Decoder Circuitry Act of 1990," that's why.

However, there are also more acceptable reasons for making the feature requisite. For example, don't be too sure that no one in your household needs captions to follow the action. The National Captioning Institute, which admittedly developed the technology, estimates that 20% of the population suffers from hearing impairments significant enough to derive benefit from the captions, and they're not all senior citizens.

Besides, says the NCI, you don't have to be deaf to enjoy its benefits. Since the captions (which appear at the bottom of the screen when a TV's caption circuit is active) generally match any program's dialogue, it's a great way to teach kids to read. Since it will allow immigrant viewers to compare spoken words with their printed form, it'll also be useful for learning to read English.

Also, if the phone rings just as the TV drama you're watching reaches it climax, just hit the mute and caption buttons on your remote. Then occasionally read the text while you converse on the phone (provided the conversation or the program is not too engrossing). When you hang up and turn the audio back on, you won't have missed any of the plot.

Even so, not everybody wants to see two lines of text at the bottom of his or her television picture, which is why captioning is switchable; It's there if you want it, not if you don't.

Captions Grow Up. Captioning has actually been available to a limited extent for the past 13 years (a similar system used extensively in Europe is even older). PBS has been particularly active in providing captions for most of its network offerings and virtually all of its shows for children already.

While there's a fair amount of captioning going on, the use of text is still in its infancy. In Europe, it displays train and plane arrivals and departures, what's playing at the cinema, news headlines and stock tables. Here it's used mainly by ABC Network affiliates to advertise upcoming programs. However, just as soon as somebody figures out how to make the system pay for itself, those black boxes will fill up with information that's available whenever you want it.

However, for a variety of reasons, decoder purchases were generally limited to senior-citizens' centers and the homes of the profoundly deaf. For one, the price of add-on decoders was about $250. Fortunately for those that need captions, experts realized that the cost of decoders could be dramatically reduced if they could be produced in huge volume (*i.e.*, if they were mandatory). Also, the additional expense of the custom integrated circuits required to handle captions could be lessened if they're designed to perform some of the conventional chores of a television circuit as well.

Exactly how much the feature is likely to cost was still a matter of conjecture at the time this was written, with some manufacturers saying the price would be zero and others putting it in the range of $5 to $20, depending on the screen size and sophistication of the set. Since all manufacturers are subject to the TV Decoder Act, whatever the increase is it will be pretty uniform across competing models. Furthermore, because of the intense competition among manufacturers and retailers for set sales, it's very likely that one or both will absorb any increase in price.

Up to now, many whose hearing is merely impaired have stayed out of the decoder market because of the large and ungainly appearence of the units. Since the new caption decoder doesn't advertise its owner's problem (being built right into the TV), it might be a hit with such individuals.

Not all TV programming is or will be captioned, but NCI spokesperson Don Thieme estimates that virtually all prime-time network programs, feature films, syndicated programs, evening newscasts (and many local-TV newscasts) are, and more are being added all the time. "In addition," he explains, "once a program or movie is captioned, the information remains, for whatever form that program takes." That means that the vast ma-

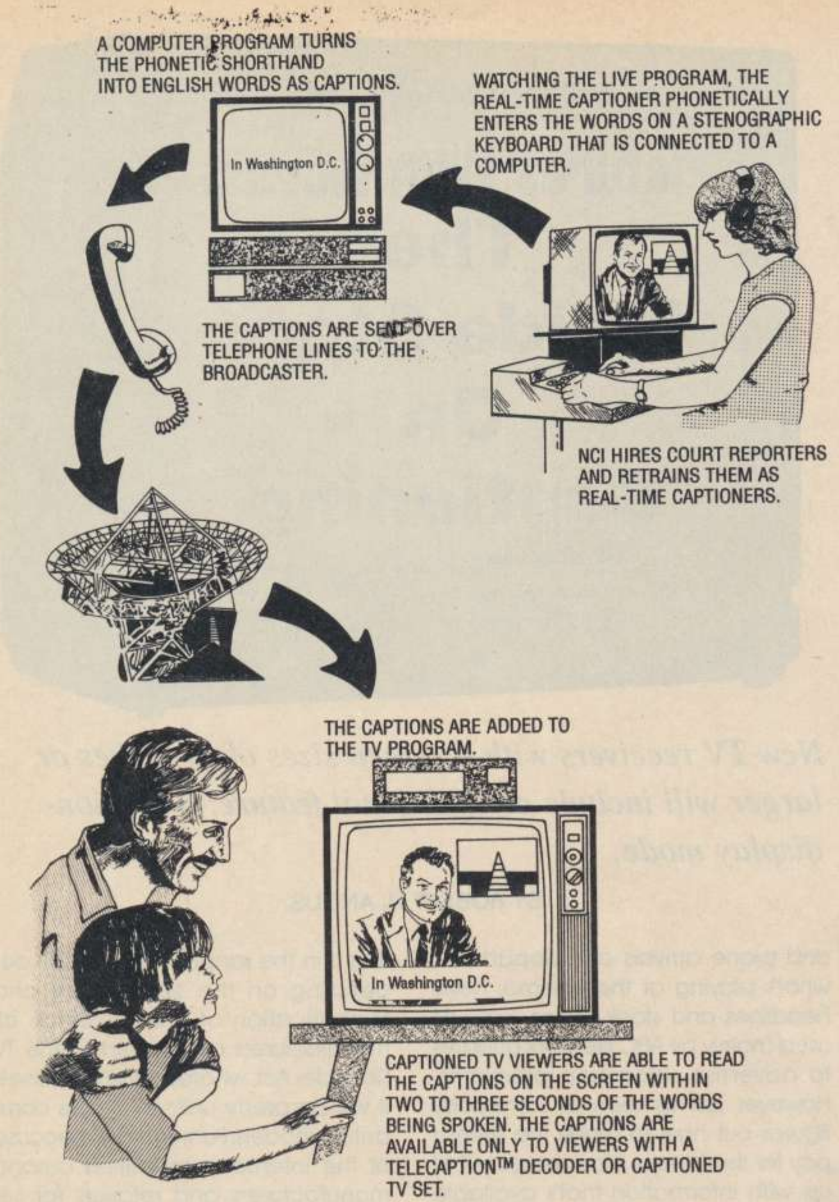

A COMPUTER PROGRAM TURNS THE PHONETIC SHORTHAND INTO ENGLISH WORDS AS CAPTIONS.
In Washington D.C.
WATCHING THE LIVE PROGRAM, THE REAL-TIME CAPTIONER PHONETICALLY ENTERS THE WORDS ON A STENOGRAPHIC KEYBOARD THAT IS CONNECTED TO A COMPUTER.
THE CAPTIONS ARE SENT OVER TELEPHONE LINES TO THE BROADCASTER.
NCI HIRES COURT REPORTERS AND RETRAINS THEM AS REAL-TIME CAPTIONERS.
THE CAPTIONS ARE ADDED TO THE TV PROGRAM.
In Washington D.C.
CAPTIONED TV VIEWERS ARE ABLE TO READ THE CAPTIONS ON THE SCREEN WITHIN TWO TO THREE SECONDS OF THE WORDS BEING SPOKEN. THE CAPTIONS ARE AVAILABLE ONLY TO VIEWERS WITH A TELECAPTION™ DECODER OR CAPTIONED TV SET.

Fig. 1. In real-time captioning a specially trained steno-typist enters the text, which is combined with the program by the broadcaster before being sent to your home.

jority of video rentals (whether disc or tape), over-the-air broadcasts, cable programming, and satellite transmissions will all contain captions.

How They're Produced. Captions are inserted as data within scan line 21 of the vertical-blanking interval—the black line that appears to separate one video frame from the next when the picture accidently rolls. On a current TV, the caption information would appear as a series of monochrome dashes within the black band. In the TV's soon-to-come, a silicon chip will detect the data, decode it, and display the information as lines of text (up to two) at the bottom of the TV picture when enabled.

Of course, the captions must first be encoded into the picture information. In the case of live programming, like sports events or newscasts, the captions are produced at the time of broadcast (see Fig. 1). That requires a court reporter able to transcribe up to 250 words per minute and specially trained for the accuracy and skills necessary to do real-time captioning. The reporter watches and listens to the live program while steno-typing the words that are being spoken. The keystrokes are fed to a computer that translates them into captions that can be transmitted simultaneously along with the TV program. So the captions appear within two to three seconds of the words having been spoken.

In the case of prerecorded material (feature films, syndicated shows, and the like), the producer sends a videocassette copy of the program to a captioning center where a trained captioner listens to the program dialogue, then types the captions making sure that the words appear *in sync* with the audio. The captioner also indicates important sound effects and places musical notes around song lyrics. He then sends a computer diskette containing all of the caption information back to the production company or studio, where it's merged with the master tape to create a captioned submaster tape—a process called encoding..

In Operation. Thanks to the use of compression techniques, there are no less than four caption modes in the system, to allow for languages in addition to English and for future growth, although generally only one is used now. In addition to the four caption modes, which permit the display of two lines of data at the bottom of the picture, there are four text-mode fields as well, all of them housed on line 21. The text occupies a somewhat large block in the center of the TV picture and allows the display of late ball scores, tomorrow's weather, the rest of the evening's TV schedule on that channel, or whatever the broadcaster chooses to put there.

To use the caption feature, most viewers would simply press a caption on/off button on their handheld remote-control once the set is turned on. The caption mode appears as text in the upper right corner of the screen (either "C1 F1," "C1 F2," "C2 F1," or "C2 F2"). You then select a mode and wait for the text to appear. The scanning system is not instantaneous, so it may take a few seconds for text to become visible even on a fully captioned program. An average wait for a fully captioned program may be six to eight seconds.

Just as not all television programs are captioned, not all parts of captioned programs contain text. For example: live interviews in local newscasts or color commentary at sports events. Thus, even though you're watching a program advertised as

(Continued on page 96)

Super Resources For Hams and SWL's

There's a wealth of information for beginners and advanced hobbyists alike in these catalogs, resource directories, and buyer's guides for the radio shack.

BY KARL T. THURBER, Jr.

Radio amateurs, shortwave listeners (SWL's), and scanner hobbyists can gain immensely from consulting the right radio catalog, resource book, directory, or buyer's guide—many of which contain excellent mini-tutorials on products and their productive uses. This article highlights several exceptionally useful and educational radio catalogs as well as several popular radio resource books and equipment-buyer's guides. The objective is to increase your knowledge of the field, describe what radio gear is available, compare competing equipment and accessories, help you make the most productive use of equipment once purchased, and/or improve your operating skills. In this article we'll sample the many available offerings in three areas: catalogs, resource books, and buyer's guides. Let's dig in.

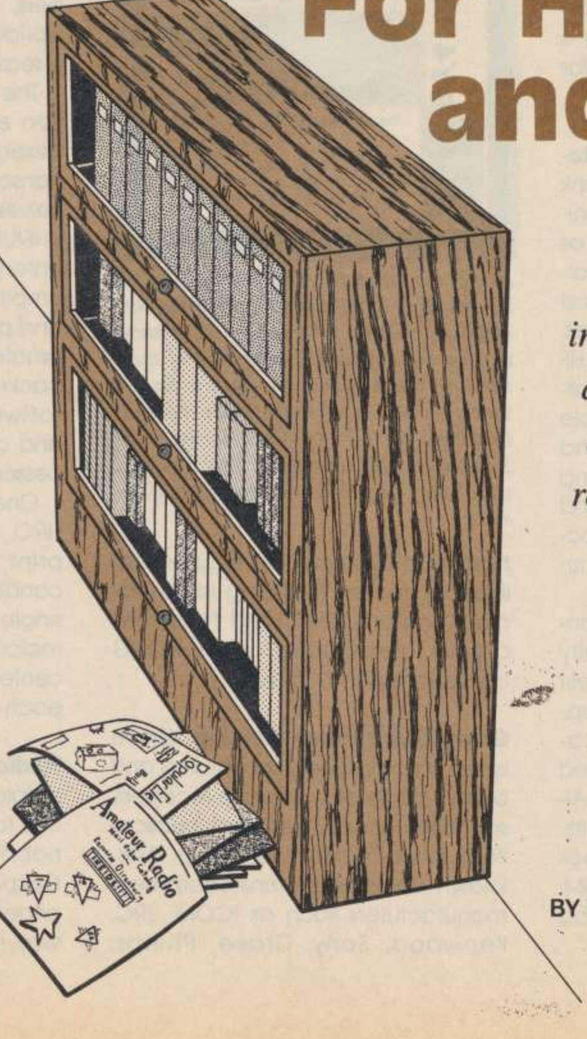
Radio Communications Catalogs. In addition to their convenience, mailorder radio catalogs extend your horizons, providing you with access to equipment and supplies that may not be locally available. Fortunately, there is an abundance of catalogs that offer a wide selection of products.

Whatever communications or electronics equipment you buy, whether new or used, you'll want to be "plugged into" what's available. First, you'll want to acquire some general equipment and parts catalogs—like those of your neighborhood Radio Shack as well as mailorder sellers such as All Electronics, Altex Electronics, Digi-Key, Jameco Electronic Components, MCM Electronics, Mouser Electronics, Parts Express, Unicorn Electronics, and others, many of which advertise in **Popular Electronics** or *Electronics Now*. For their numbers addresses, as well as those for the other companies we'll mention in this article, see the sidebar entitled "Names and Numbers."

Next, you'll want to obtain the specialized radio-communications catalogs of mail-order radio-equipment and accessory dealers and distributors such as Amateur Electronic Supply, Electronic Equipment Bank, Gilfer Shortwave, Grove Enterprises, Ham Radio Outlet, The Radio Works, and Universal Radio, to name a few. The catalogs we've selected were chosen for one or more of several reasons: either they're free, they're extra thick, they contain educational material, or they possess a combination of these attributes. Let's get to the first of those catalogs.

Amateur Electronic Supply Catalog. AES is one of the country's largest amateur-radio-equipment dealers. Since 1957, they have taken pride in their large stock of new ham gear, top trade-in quotes, and a considerable inventory of quality used gear. AES periodically issues a thick (over 140 pages) catalog that's an industry "bible." It's especially useful to the newcomer since its directory-style listings are great for new-equipment-reference and price-comparison purposes. Another section lists used amateur-radio equipment and offers special prices on new gear in opened cartons and in-store demonstrators.

The new-equipment pages take the form of condensed, telephone-book style listings of amateur-radio equipment, scanners, shortwave radios, power amplifiers, test equipment, antennas, antenna-rotors, repeaters, packet radio equipment, wire, cable, and other communications equipment and accessories. The entries show the manufacturer, manufacturer's part number, product name, "regular" price, and the AES "sale price."



The new-equipment entries also display codes that show special conditions, such as items too large for UPS or too valuable for freight, close-out items, and low-priced items that won't be restocked when the present stock is sold. Manufacturers' advertisements and expanded product descriptions supplement the listings.

Near the back of the catalog is used ham-radio equipment. The gear is fully tested and offered on a 10-day trial/30-day guarantee basis, with full credit within 90 days on the higher priced new equipment. Also shown are special prices on new gear that has been demonstrated, on display, or restocked; the cartons are unsealed but each item carries a new-equipment warranty. Catalog codings show in which AES stores the items are available—AES currently operates stores in Milwaukee, WI; Wickliffe, OH; Orlando, FL; Clearwater, FL; and Las Vegas, NV.

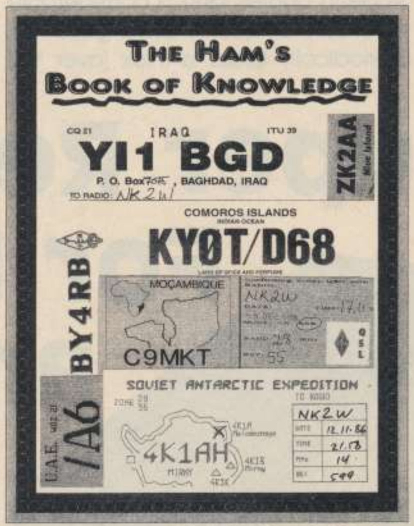
The AES catalog is free and can be obtained by sending your name, address, and amateur call-sign (if any) on a postcard; they are sent out bulk mail. No phone requests can be taken. If you're in a hurry and want a catalog by 1st-class mail, send $5 for postage and handling.

Electronic Equipment Bank Catalog. The Electronic Equipment Bank (EEB) is a full-service radio-communications supplier, one that bills itself as "the nation's largest shortwave dealer." EEB's catalog is of special interest to the SWL and scanner enthusiast. Included are a variety of desktop HF and VHF/UHF receivers, scanners, satellite-receiving equipment, portable and handheld receivers, RTTY and FAX adapters, custom SW-receiving equipment, computer interfaces and control systems, antennas, radio accessories and supplies, and communications books.

The EEB catalog also contains manufacturers' advertisements, specialty items and accessories, and test equipment. EEB also is active in supplying creative receiver modifications, rack mounts, and specialized radio applications and systems. Although EEB's focus is on shortwave receiving equipment, they also stock amateur equipment, including ICOM, Yaesu, and Kenwood. The catalog cover price is $4.95.

Gilfer Shortwave Catalog. For the serious shortwave listener, one of the best catalogs is published by Gilfer Shortwave, which considers itself "America's premier SWL center." Their over 30-page catalog is free and makes a good shortwave source book. Gilfer, located in the northern New Jersey suburbs of New York City, was formed during the Korean War years by the late Oliver P. (Perry) Ferrell, a respected magazine editor and avid SWL.

Gilfer Shortwave presently sells a wide variety of receivers, other hardware, and books especially for the SWL. Numerous accessories are offered, including passive and active antennas, lightning arrestors, surge protectors, and cable sets. Several high-quality imported equipment lines are stocked, including Japan Radio Company (JRC) and Philips receivers, and Dressler and DATONG active (amplified) antennas.



Here's the cover for The Ham's Book of Knowledge. *It's a compilation of the sort of hobby-related information that hams use for the day-to-day operation of their stations; much of which is hard to find or seems to be out of reach when needed. Published in 8-½ × 11-inch format, the 256-page book consists of two sections, which may be purchased separately if desired.*

Grove Enterprises Catalog. Grove issues a comprehensive catalog and buyer's guide of shortwave receivers, scanners, accessories, and publications that's free for the asking. Well-known communications-equipment manufacturers such as ICOM, JRC, Kenwood, Sony, Drake, Philips, Sangean, Uniden/Bearcat, and MFJ, as well as Grove's own product line (including a custom SWL receiver and a spectrum display unit), are featured. Of primary interest to SWL's and scanner hobbyists, the catalog has useful hints and tips for the listener, including tutorials on choosing a shortwave receiver, scanner radio, antenna, and accessories.

Grove Enterprises also publishes *Monitoring Times*, which is dedicated to the communications-monitoring hobby. Issued monthly, the newspaper-style journal focuses on "world band listening" and includes international broadcasting schedules, frequency listings, station profiles, propagation charts, VHF/UHF monitoring tips and information, and more. A one year subscription is $19.95; a sample copy is $3.

Ham Radio Outlet Catalog. Ham Radio Outlet (HRO) is one of the top amateur-radio-equipment dealers, boasting that it's "the world's largest ham outlet." Its 11 stores, network of five regional toll-free telephone numbers, two FAX order numbers, and worldwide distribution make its claim a reasonable one.

The 100+-page HRO communication equipment catalog is well-indexed. It features amateur VHF/UHF transceivers, handheld radios, HF receivers and transceivers, SWL radios, VHF/UHF scanners, mobile and fixed antennas, masts, towers, RF power amplifiers, antenna rotors and tuners, and power supplies. Also offered are amateur television (ATV) equipment, packet-radio controllers, ham-shack software, communications books, and a wide selection of station accessories.

One particularly nice feature of the HRO catalog is that all the "fine print"—the company's terms and conditions—are consolidated on a single page. Another is that motel-directory-style maps provided on the centerfold pages show how to get to each store location.

Radioware Catalog. A free, 52-page catalog of antennas and RF accessories for amateur, SWL, and scanner hobbyists is offered by Radioware Corporation. The company takes pride in its approach to customer service, noting that Radioware "is run by radio hobbyists to serve radio hobbyists."

The catalog's focus is on RF products. Among its offerings are amateur, SWL, and scanner antennas for HF, VHF, and UHF; antenna wire; multiband antenna traps; transmitting and receiving RFI filters; antenna relays; lightning-protection and grounding accessories; mobile mounts; and other antenna components and accessories. Almost everything in the catalog is illustrated with a photo.

The Radio Works Catalogs. Jim Thompson, W4THU, The Radio Works' proprietor, has been involved in building wire-antenna systems and baluns since 1984. The catalog's central focus is on HF wire-antenna systems, high-power baluns, and antenna components such as coaxial cable, antenna wire, and connectors.

The Radio Works General Catalog costs $2. It covers most anything anyone could need to assemble their own wire antenna, including insulators, sealant, antenna tuners, surge protectors, mounts, guy rope, wire, cable, and connectors. The catalog features both his own heavy-duty baluns and preassembled antennas (windoms, loops, double zepps, G5RV's, etc.) as well as selected systems and components from other manufacturers. The information is in an easy-to-read style and extensively illustrated.

The Radio Works recently added a new Reference Catalog, distinct from the General Catalog, a source book that reads more like a magazine than a catalog. While the General Catalog runs about 48 pages, the Reference Catalog is 128 pages; together, the two total over 175 pages of useful technical and pricing information on building, installing, and optimizing HF wire antenna systems and maximizing station or listening-post performance.

More than just a product listing, the Reference Catalog is billed as the "wire antenna discovery book," and contains several articles. There are features on high-performance wire antennas, installing skywires in trees, knots and pulleys, and more. Several pages are dedicated to antenna-support considerations, and a section is devoted to solving ground problems.

The two catalogs, with their considerable tutorial and reference material, make excellent source books for high-performance wire antennas that are suitable for the beginner in amateur radio or shortwave listening. Both catalogs are available as a set for $4 postpaid.

Scanner World Catalog. If you're a VHF/UHF scanner enthusiast, a nearly indispensable catalog is offered by Scanner World, USA, which considers itself "the largest dealer of scanners in the world." The free 60-page catalog covers practically anything you might need or want to equip your shortwave-radio or scanner listening post. Included are base-station, mobile, and handheld scanners and CB-radio gear from a variety of manufacturers; base-station and mobile antennas for scanners and CB radios; frequency converters; telephones; various other accessories; and communications books. The catalog lists at $3.

Universal Radio Communications Catalog. Universal Radio opened its doors in 1942, making it one of the oldest retail radio stores in the nation. Then called Universal Service, it was founded early in World War II by F. R. "Gibby" Gibb, W8IJ, and featured the now-just-memories amateur brands such as Hammarlund, Hallicrafters, Johnson, and National.

For years, Universal Radio issued two separate catalogs: the Amateur Radio Catalog and the Shortwave Catalog, and later also issued a Scanner Catalog. These were hefty publications that separately described Universal's wide range of products offered to amateurs, SWL's, and scanner buffs. In recent years, they have consolidated the three catalogs in a combined 8-½ × 11-inch Communications Catalog.

The complete catalog is, of course, considerably thicker than any of its predecessors and covers a wide variety of equipment for the amateur-radio, SWL, or scanner enthusiast. An impressive selection of amateur and shortwave antennas, headphones, books and other publications, and accessories is featured. In its present format, the 100+-page catalog makes an authoritative buyer's guide, source book, and desk reference for all components of the radio-communications hobby. The catalog is free upon request by fourth-class mail ($1 for first-class mail or for four IRC's outside North America).

1993 Volume 3 Number One
Amateur Radio
Mail Order Catalog
and
Resource Directory
1650+ Listings From A to Z
Includes Ham-Soft Shareware Catalog
216 Categories
Plus! W6DDB's Library of Tips

A top-notch resource is the Amateur Radio Mail Order Catalog and Resource Directory. *This "who's-who-in-the-business" directory helps you find the right vendors for practically every ham-shack need. The January 1993 edition, the cover of which is shown here, contains more than 1,650 entries in 216 categories.*

Books From the ARRL. In the sections that follow, we'll present some useful communications resource books and directories you may wish to add to your bookshelf. Some are more useful to licensed radio amateurs, others to SWL's, and still others to scanner buffs. Some are hardware oriented, while others focus on operating techniques. Let's start with some reference books from the American Radio Relay League (ARRL).

The ARRL offers scores of "must-have" publications that form the core of a good ham-shack library. Of the hundreds of ARRL publications, perhaps a dozen or more can be considered to be essential desktop references. These include such publications as *The ARRL Operating Manual* ($18), *The ARRL Electronics Data Book* ($12), *Hints and Kinks for the Radio Amateur* ($9), *The ARRL Repeater Directory* ($6), and others. Two of the most widely read, respected, and encyclopedic League publications are *The ARRL Handbook* and *The ARRL Antenna Book.*

The ARRL Handbook, the "ham's bible," has been one of the most comprehensive amateur radio source books since 1926. It's intended as a reference guide, a tutor on radio theory, and a goldmine of construction projects. The 1993 69th Edition, which has 1200 pages and 2100 charts and illustrations in an 8-½ × 11-inch format, costs $25. Its many chapters include radio principles, radio transmission, construction and maintenance, and on-the-air practices.

The ARRL Antenna Book is a good source of information on antennas, transmission-line theory, and antenna construction. The latest edition contains over 700 pages and nearly 1000 illustrations. Focus is on antenna fundamentals such as safety, propagation, transmission lines, yagis, quads, and wire antennas. Covered are antennas for portable, mobile, limited space, VHF/UHF/microwave, and space communications. It's $20. (Note: an ARRL publications catalog is printed each month in *QST*, the official League journal.)

The Amateur Radio DX Blue Book. This reference book is aimed at the amateur who's into DX communications. Revised twice yearly, it provides information on each international call-sign prefix. The book lists each International Telecommunications Union (ITU) prefix with its attributes, including country, capital, radio zone, DX Century Club (DXCC) status, UTC differential, reciprocal and third-party operating information, number of amateurs, and map grids.

Also provided are country listings with prefixes, the complete ITU call-sign-prefix assignments, a frequency-spectrum chart showing amateur-band allocations, the phonetic alphabet, "Q-signals," QSL- (confirmation-) card procedures, and more. Fold-out 11 × 17-inch regional prefix-designated maps provide further support. Also included are English/Russian scripted sample QSO's (contacts) with simplified pronunciations and displays of Cyrillic words and special Morse-code characters. The 1993 spiral bound edition is $6.95 plus $1.50 shipping and handling (S/H). *The Amateur Radio DX Blue Book* is published by Jim Creevay, W4UYZ, through J-C Enterprises.

A Catalog and Resource Directory. A very comprehensive communications resource book is offered by John Hart, N0OCF; it's the *Amateur Radio Mail Order Catalog and Resource Directory*. This "yellow-pages" style directory helps you find the right vendors for practically everything for the radio shack—the January 1993 edition has over 1,650 entries. The directory originally was designed so newcomers to the hobby could have one source book for everyone in the mail-order business.

Within its 260, pages there's a detailed table of contents and index,

Names and Numbers.

All Electronics,
PO Box 567,
Van Nuys, CA 91408;
Tel. 800-826-5432.

Altex Electronics, Inc.,
11342 I-35 North,
San Antonio, TX 78233;
Tel. 800-531-5369.

Amateur Electronic Supply, Inc.,
5710 W. Good Hope Road,
Milwaukee, WI 53223;
Tel. 800-558-0411.

American Radio Relay League,
225 Main St.,
Newington, CT 06111;
Tel. 203-666-1541.

Artsci, Inc.,
PO Box 1848,
Burbank, CA 91507;
Tel. 818-843-4080.

Billboard Books,
PO Box 2013,
Lakewood, NJ 08701.

CQ Communications, Inc.,
76 N. Broadway,
Hicksville, NY 11801;
Tel. 516-681-2922.

Digi-Key,
PO Box 677,
Thief River Falls, MN 56701;
Tel. 800-344-4539.

Electronic Equipment Bank,
323 Mill St., N. E.,
Vienna, VA 22180;
Tel. 800-368-3270.

Gilfer Shortwave,
52 Park Avenue,
Park Ridge, NJ 07656;
Tel. 800-GILFER-1 (800-445-3371).

Grove Enterprises,
PO Box 98, 140 Dog Branch Road,
Brasstown, NC 28902;
Tel. 800-438-8155.

Ham Radio Bookstore,
PO Box 209,
Rindge, NH 03461-0209;
Tel. 800-457-7373.

Ham Radio Outlet,
933 N. Euclid St.,
Anaheim, CA 92801;
Tel. 800-444-0047 (east)
or 800-854-6046 (west).

Hart Publishing,
767 South Xenon Court., #117,
Lakewood CO 80228;
Tel. 303-987-9442.

HighText Publications, Inc.,
125 North Acacia Avenue, Suite110,
Solana Beach, CA 90275;
Tel. 800-888-4741.

Jameco Electronic Components,
1355 Shoreway Road,
Belmont, CA 94002;
Tel. 800-831-4242.

J-C Enterprises,
4920 Mayflower St.,
Cocoa, FL 32927;
Tel. 407-632-6809.

MCM Electronics,
650 Congress Park Dr.,
Centerville, OH 45459-4072;
Tel. 800-543-4330.

Mouser Electronics,
2401 Highway 287 North,
Mansfield, TX 76063;
Tel. 800-992-9943.

Parts Express,
340 E. First St.,
Dayton, OH 45402;
Tel. 800-338-0531.

RSM Communications,
PO Box 1046,
Key Largo, FL 33037;
Tel. 305-853-0379.

Radioware Corporation,
87 Belmont St.,
N. Andover, MA 01845;
Tel. 800-950-WARE (800-950-9273).

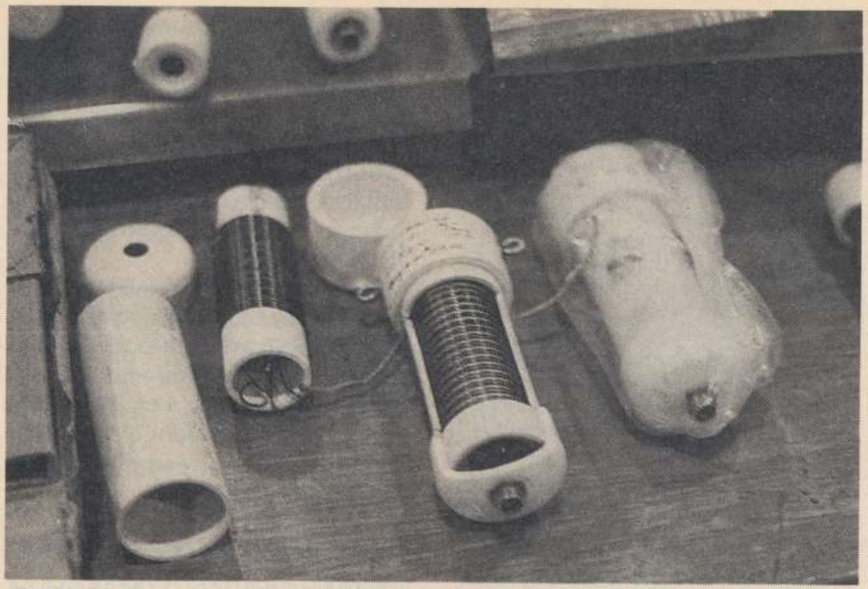
The Radio Works,
PO Box 5169,
Portsmouth, VA 23703;
Tel. 804-484-0140.

Scanner World, USA,
10 New Scotland Avenue,
Albany, NY 12208;
Tel. 518-436-9606.

Ed Schneider, AA7AN,
6502 Wildcat Drive,
Cave Creek, AZ 85331;
Tel. 602-488-4325.

Unicorn Electronics,
10010 Canoga Avenue,
Unit B-8,
Chatsworth, CA 91311;
Tel. 800-824-3432.

Universal Radio, Inc.,
6830 Americana Pkwy.,
Reynoldsburg, OH 43068;
Tel. 800-431-3939.



The Radio Works General and Reference Catalogs *are devoted to the design and construction of HF wire antennas and important ancillary components and devices. For example they feature and show how to use a variety of efficient baluns (like those shown here) that provide a low loss interface between unbalanced coax and balanced antennas.*

If you're a newcomer, deciding whether to start with a new or used receiver is a big decision. Well-known brands among older sets include Drake, Collins, Hallicrafters, National Radio, Hammarlund, RME, and TMC. The classic Hallicrafters SX-62A, circa 1955–1963, is shown here; this vacuum-tube radio was for years a favorite among SWL's. Comprehensive radio receiver resource directories such as those mentioned in this article help you make wise equipment selections.

plus directories of catalogs and references, books and other publications, radio clubs and associations, computer bulletin boards (BBS'es), radio magazines, and more. The 1,650-entry directory is broken down into 216 categories of vendors, topics, parts, products, services, and publications. The book is well-indexed. Also included is the complete Ham-Soft shareware and public domain software catalog and Bill Welsh's, W6DDB Library of Tips for Hams which includes useful abbreviations, terms, tips, and knowledge for beginners and veterans alike.

The directory is published twice yearly. The main edition is published in January, and there's a July supplement; the latter is necessary because in six months, many vendors will change addresses; cease business; or add new product lines, phone lines, and FAX numbers, and many new vendors will open their doors.

The single issue price is $14.95 plus $3 USPS Priority Mail; the July supplement is $5. The directory is from Hart Publishing.

Artsci Publications. Artsci specializes in reference publications for the radio amateur, SWL, and scanner enthusiast. Among these are the *Amateur HamBook*, a $14.95 reference compendium with numerous charts, tables, construction plans and drawings, and other useful information; *Radio/Tech Modifications*, available in several different series for Alinco, Kenwood, ICOM, Standard, Yaesu, and other radios and scanners, priced at $19.95 each; and *Lost Users Manuals*, a $19.95 publication that offers condensed VHF/UHF mobile, handheld, and scanner radio programming and operating instructions—very useful if you're in the predicament of having lost your set's manual.

Artsci also publishes *Federal Government Frequency Assignments*, a $24.95 master frequency file that's a "must" for sophisticated scanner monitors; *U.S. Repeater MapBook*, which at $9.95 has maps of all 50 states as well as the rest of North America, clearly annotated with popular open amateur repeater locations and frequencies; and the *North American Shortwave Frequency Guide*, priced at $19.95, that shows popular English- and Spanish-language shortwave broadcast frequencies. Contact Artsci for a free catalog.

DX/SWL Press Books. Authored by Harry Helms, AA6FW, *The Shortwave Listening Guidebook* is 316 pages in a 6 × 9-inch format. It offers SWL's 11 chapters and six appendices of useful and understandable information on when, where, and how to hear the world via shortwave radio. The book includes advice and guidelines on receiver selection, propagation, receiver operation, obtaining program schedules, profiles of major international broadcasters, and popular frequencies to monitor. There are chapters on antennas and accessories; FM, TV, and broadcast band DX'ing; amateur radio; and even unusual and mysterious radio stations, including clandestine and pirate broadcasters. It's $16.95 plus $3.00 S/H.

A second Helms DX/SWL Press book, *All About Ham Radio,* is aimed at the newcomer to amateur radio. In 291 pages, the author effectively uses humor and a friendly style to guide newcomers. The book isn't a complete license course or A-to-Z operating reference. However, unlike many other beginner texts, this one devotes just about as much attention to what amateurs actually do and to the amateur-radio culture as it does to technical, formal operating topics.

The Helms book evaluates the pros and cons of the Novice and Technician licenses as hobby entry points. Since the book is published independent of any radio organization or manufacturer, it straightforwardly covers topics without equivocation. The book discusses the roles played by the FCC and the ARRL, and it reviews current radio magazines and license study materials.

The 6 × 9 inches softcover is $19.95. Like *The Shortwave Listening Guidebook,* it's available from radio-equipment dealers, technical booksellers, and directly from the publisher with $3 S/H.

The Ham's Book of Knowledge. Edmund Schneider, AA7AN, publishes *The Ham's Book of Knowledge* that contains an extensive collection of operating and technical information for the amateur. In 8-½ × 11-inch format, the 256-page book has two sections, which may be purchased separately if desired. The first section contains the bulk of the reference text and technical data, while the second contains beam headings, dealer and manufacturer lists, and operating information.

The author has effectively compiled in one place the most-often used hobby-related information that hams need in the day-to-day operation of their stations; much of this is hard to find information that's often out of reach when needed. A few of the many items included are personalized beam headings; time zones; manufacturer, dealer, and equipment lists; third-party traffic restrictions; radio formulas and conversions; geographic and demographic data; feedline information; prefix lists; and QSL information. Various charts, diagrams, and photos are included.

Used Vs. New Communications Equipment

Owning new, state-of-the-art radio-communications equipment is usually best if you can afford it, but used radio gear may provide better values than new. Why? Depreciation and obsolescence extract a heavy toll on radio gear. Actual prices for used gear, like anything else, depend on the condition of the equipment, terms of sale, current demand, who's selling it, warranty costs, and other factors.

Equipment sources include local amateurs, radio hobbyists, club members; classified ads; individual flea market and hamfest sellers; and used-equipment dealers. Buying from individuals can be cost-effective, but satisfaction depends largely on the personal integrity of the seller. But, whether you buy new or used, you must know what you're after, and that's when a buyer's guide or other reference source book comes in handy.

In practice, you may fare better buying used equipment (receivers, transmitters, and transceivers) from a dealer who sells used gear that's been traded in on new equipment, rather than buying a "pig-in-a-poke" from an individual at a flea market site. The dealer often offers a 30–90 day warranty and, in some cases, a return privilege, so you shouldn't be stuck.

Scouting equipment by mail from a store specializing in used gear is usually satisfactory, since many accept "clean" trade-ins on new equipment and they dispose of it through their own used gear departments. Normally, the gear is at least checked over, and usually it's put into working order; in some cases it's reconditioned to like-new condition. ■

The Ham's Book of Knowledge is $23 plus shipping ($7 UPS domestic 2nd day air or $4 surface) from Ed Schneider, AA7AN, 6502 Wildcat Drive, Cave Creek, AZ 85331; (602) 488-4325. Each of the two sections may be purchased separately for $12.

Passport to World Band Radio . As a guide to world shortwave listening, *Passport to World Band Radio* by Larry Magne is considered by many to be a "must" for SWL's. It's a comprehensive, quick-access guide to shortwave broadcasting in the 2.3- to 26-MHz broadcasting range. Outlets in over 150 countries are presented in a unique "spectrum occupancy chart" format. The guide shows essential information such as station name and location, transmitter power, transmission time periods, languages used, and target areas. The book also features a comprehensive buyer's guide that includes the author's critical, respected reviews of some 90 shortwave receivers.

The 390-page, 7 × 10-inch annual is published by IBS and priced at $16.95. It's available from many bookstores as well as mail-order communications stores and dealers, including Electronic Equipment Bank (EEB), Gilfer Shortwave, Grove Enterprises, Universal Radio, and others.

World Radio and TV Handbook. The *World Radio and TV Handbook* (or WRTH) is an authoritative, encyclopedic station guide that long has been recognized as the most up-to-date publication on the world's long, medium, and shortwave-radio and -television stations. The $19.95, 608-page 1993 edition has more than 80 pages of long- and medium-wave station listings, 25 pages of shortwave stations arranged in frequency order, and 40 pages showing television stations. The Handbook contains an annual review of shortwave receivers, names and addresses of international-radio listener clubs and key broadcasting personnel, and maps showing current geopolitical boundaries and principal transmitter sites. It is distributed by Billboard Books.

Buyer's Guides. There comes a day when you do more than browse: you set your sights on a new piece of radio-communications gear—perhaps a receiver, transmitter, transceiver, scanner, antenna, accessory, or whatever. At that point, you must find a way to cut through the advertising hoopla and make intelligent comparisons and choices. A buyer's guide can provide that kind of help, and there are several from which to choose.

For example, *The ARRL Radio Buyer's Source Book* is a publication is designed for anyone who buys, sells, or owns amateur-radio equipment. The Source book includes published *QST* magazine lab reviews of HF and VHF transceivers, RF power amplifiers, and accessories. It tells what the equipment does, how well it does it, where

(Continued on page 92)

Build an Audio Interface for your Telephone

Record and play back telephone conversations with the highest possible audio quality

BY GEORGE BELVA

Have you ever needed to record a conversation or some other type of communication directly from the phone line, but found it difficult, if not impossible, to get quality audio using inexpensive equipment? Or, on the flip side, have you ever want to playback a recording over the phone and have it sound half-way decent? Putting a speaker against the telephone mouthpiece is not the answer, and using one of those cheap (literally) magnetic couplers is often worse.

Of course, there are some fancy (read that as "very expensive") electronic do-dads that provide excellent two-way audio coupling, but such equipment would be overkill for occasional needs and most budgets. The gadget—the *Telephone Audio Interface*—described in this article is a very simple and compact coupler (measuring only 1.95 × 2.2 × .8 inches) that allows you to alternately pick audio from or feed audio into the phone line with surprising quality.

The interface requires no power (not even from the phone line) to operate. It is also easily portable, and can be use with any recorder (cassette or otherwise) that has a microphone or line input and an earphone or line output.

About the Circuit. A schematic diagram of the Telephone Audio Interface is shown in Fig. 1. The interface (with its deceptively simple appearance) provides the isolation necessary to connect the phone line to an audio circuit without presenting any danger to the phone line, audio gear, or the operator. Essentially, the interface is a simple isolation circuit, built around 4 components (C1, R1, R2, and T1), 3 connectors (PL1, PL2, and SO1), a switch (S1), and some wire.

In the interface circuit, C1 prevents the phone line's 48-volt DC from saturating transformer T1, and hence the phone loop from signaling an off hook condition (otherwise, callers would get a busy signal). It also prevents the ring voltage (which can get up to the 90 volts, at 20- to 30-Hz) from reaching the audio circuit and possibly damaging it, while allowing audio (an alternating signal) to pass through the transformer to the connected equipment. Finally, C1 prevents the phone-line voltage from shorting through T1 (remember, to DC, a transformer appears to be a dead short).

The capacitor's 250-volt rating allows plenty of room to drop the ringing voltage without any danger of damaging the capacitor. Most of the 90-volt, 20- to 30-Hz ring signal is dropped across the capacitor, which, at that frequency exhibits a high impedance. The transformer's impedance (although slightly elevated at that frequency) is comparatively low. One the other hand, the in-coming and out-going audio "sees" a much lower capacitive impedance.

The value of C1 can range from less than 1 μF upward; it really isn't critical. However, whatever value you choose, it should be rated for no less than a 250 volts; remember the ringing voltage can average around 90 volts, and with surges, can rise far beyond that level.

Transformer T1 is a 600:600-ohm miniature audio transformer that has a reasonable audio response. Its function in the circuit is to completely isolate the phone line from the audio equipment. That's necessary since any grounding or voltages presented to the phone line may damage or adversely affect phone-company equipment; for example, the equipment might hang up, signal an off-hook condition, short out, etc. The isolation also allows you to place just about anything you want on the secondary of the transformer.

One word of caution here, however: It is still possible to load down the phone line (audio wise) so that a

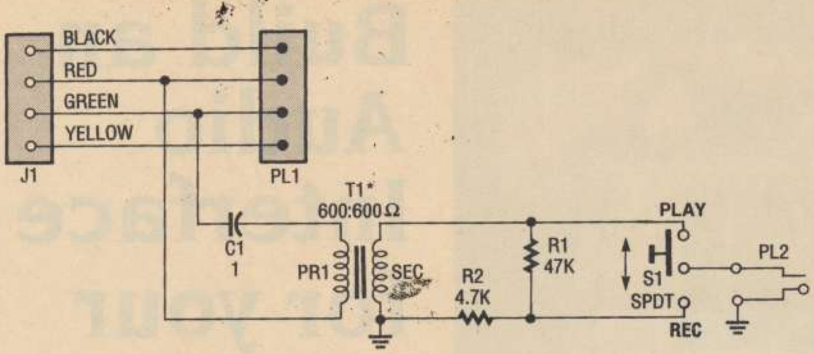


Fig. 1. The Telephone Audio Interface—essentially, a simple isolation/coupler circuit—isolates the phone line from any connected audio circuit without presenting any danger to the phone line, the equipment, or the user.

PARTS LIST FOR THE TELEPHONE AUDIO INTERFACE

R1—47,000-ohm, ¼-watt, 5% resistor
R2—4700-ohm, ¼-watt, 5% resistor
C1—1-µF, 250-WVDC, metallized-polyester capacitor
T1—600:600-ohm, 75-mW, miniature audio transformer
S1—SPDT miniature slide or toggle switch
PL2—3.5-mm phone plug
PL1—4-conductor modular telephone plug
J1—4-conductor surface-mounted modular telephone jack
Single-conductor, shielded audio cable, quad-conductor modular telephone cable, small plastic cable tie, wire, solder, hardware, etc.

Note: A kit of parts is available from Belva Electronics (309 Third Ave., Vestal, NY 13850) for $15.00; a working unit is also available for $25.00. New York State residents, please add appropriate sales tax.

weak DTMF (tone-dialed) phone will no longer signal the phone company equipment properly. (That event will be discussed in the "Modifications and Limitations" portion of this article).

In addition to its avowed function, T1 also provides a 600-ohm match to the phone line. Although that match is not perfect, it is good enough for what we are doing. The reason for choosing a 600:600-ohm transformer is for its simplicity while providing a reasonable match in extreme conditions, which will be encountered when switching from record to play using an average cassette recorder.

When S1 is in the REC position, the incoming audio is fed through a resistor-divider network (comprised of R1 and R2), which, at the resistor junction, provides a close approximation of a line-level audio signal that is excellent for recording. The network was designed to give a hot-mike-like level since the circuit is meant to be used with a cassette recorder that's equipped with automatic-level control. That helps to equalize the differences between the local audio level and the in-coming audio. When S1 is in the PLAY position, the audio signal (from the recorder or other source) is fed directly to T1 for playback over the phone line.

Construction. The circuit is so simple that no board of any kind is required; instead, the author's unit was assembled in a surface-mount modular telephone jack enclosure using point-to-point wiring techniques. Note however, that not all such jacks are created equal. The one used in the author's prototype is an 8-contact type. The photo shown in Fig. 2 will give you some idea of what to look for if your unit is to be assembled and packaged in the same way. If you choose to do otherwise, you can house the unit in any type of enclosure that you choose. Note that a kit is offered by the supplier listed in the Parts List.

If you decide to take the same approach, the jack enclosure used must have no screws through the center and enough hollow space within to accommodate the parts. Pop off the cover; you'll have to drill holes in the cover to accommodated the switch's mounting hardware and its slide lever. The jack housing used to house the author's unit is shown at the top-left of Fig. 2. Note that that unit has 8 terminal positions: one in each of the four corners, and two each on either side of the enclosure.

The screw terminals must be adjusted so that all four are in the center four holes: the wires from th RJ-11 jack must be disconnected from the terminals: Do not cut the spade lugs off those wires. Once disconnected, move the wires up and back so that the maximum amount of inner box space is exposed. Place the box in front of you with the RJ-11 jack at the top and the holes for the wires at the bottom (closer to you).

Place the capacitor in the box (as shown in the top-center of Fig. 2) at the connector end. Depending on the physical dimension of the unit, the capacitor may be a snug fit. Should that situation arise, simply file away some of the plastic box until the unit fits. Wrap the right lead of the capacitor under the lower-right screw terminal of the box.

Twist one lead of the two resistors together and solder. Clip off the center tap on both sides of the transformer. Bend the small tabs of the transformer (if any are present) over and flat. Place a piece of tape across the bottom side of the transformer. Make sure it is completely covered with a good electrical tape. Solder the resistors to the transformer leads (either primary or secondary). Make sure the 4.7k resistor is on the right side with the junction of the two resistors pointing away (up) from you.

Bend other lead of the capacitor in toward the capacitor body and up so that it can be soldered to the left lead of the transformer (opposite from where resistors are soldered). The right lead of that side of the transformer is then soldered to the crimp end of the spade lug that's attached to the red wire coming from the enclosure's internal RJ-11 jack. The spade lug is then placed under the upper right screw terminal. (Placing the spade under the terminal first, then lightly tightening the screw, and finally soldering the transformer lead to the spade lug makes things a bit easier). At this point the assembly should resemble the one shown at the top-right of Fig. 2.

Remove about 2 inches of the outer insulation from the quad telephone

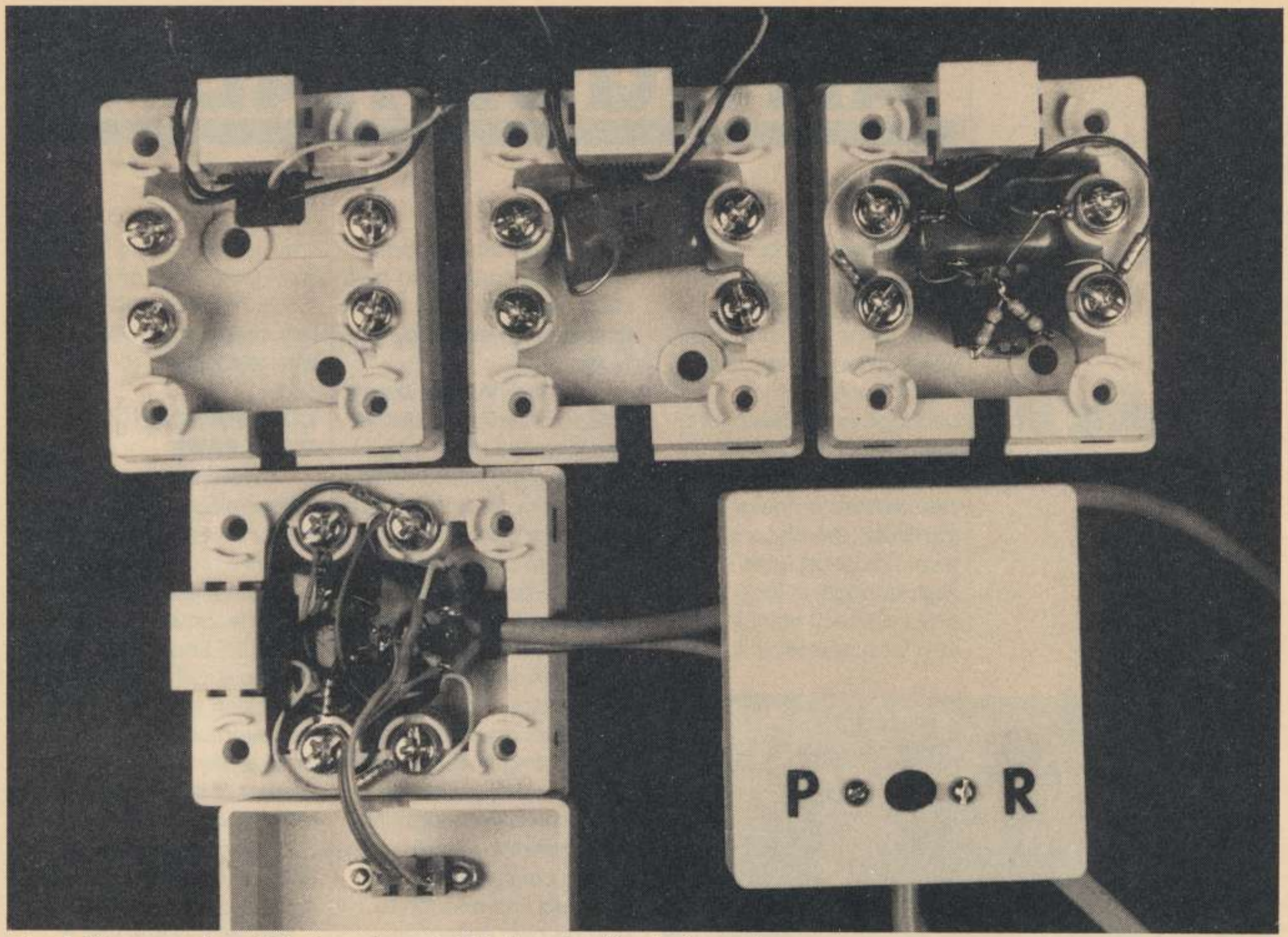


Fig. 2. The top portion of this photo shows the Telephone Interface during various stages during construction; the bottom portion shows internal and external views of the finished project.

cable, remove about a half inch of the color-coded insulation from the individual leads, and then tin the leads. Remove about a half inch of the audio cable's outer insulation to expose its center conductor and copper braid. Twist the copper braid and then remove about ⅛-inch of insulation from the center conductor. Place the two cables together so that the ends of the outer jackets line up, and secure them together with a cable tie placed about ⅜-inch down from the ends of the outer jackets. Make sure that they are tied tight.

Place the cable assembly into the case as shown at the lower-left in Fig. 2. That may be a little tough because it was meant to be tight. The best way to accomplish that is to spread the cable ends apart above the wire tie so that the audio cable is on the right and the quad telephone cable is on the left. Use a flat-blade screwdriver and carefully force the assembly down and around the transformer. Solder the audio-cable shield to the lower right transformer lead. That's where the 4.7k resistor should already be soldered.

Connect the quad-conductor telephone cable's leads to the four screws. The red wire connects to the red wire from the case; the green wire connects with the other green wire under the lower-right screw with the capacitor lead. The black wire connects with the case black wire under the upper-left screw and the yellow wire connects with the case yellow wire under the lower-left screw. Note the position of each of the spade lugs under the screw terminals.

Next mount the switch. Depending on what you use for a switch, you may need one or three holes. If you elect to use a slide switch, start by marking two points on either side of the box about 0.45 inches up from the wire hole end of the case. Draw a line across the case intersecting those two points (figure seven). This is your center line for all three holes. Place a cross mark on that line one inch from either end of the box. That is your center hole. You may have to ream out the center hole and make it oblong for the slide switch to work. Alternately, you can use a miniature toggle switch. That requires only one round hole. Note however that you only have about a ¼-inch wide maximum space for the switch.

Regardless of the switch that you choose, prepare three, 2-inch lengths of #24 stranded wire. Solder them to the three switch terminals. Connect the center terminal of the switch (common) to the center conductor of the audio cable. You may want to use heat-shrink tubing on the connection. Connect the other two leads across the 47k resistor (R1). Decide which switch position you want for record and playback and then connect the wires as follows: The record position (for microphone recording) is the

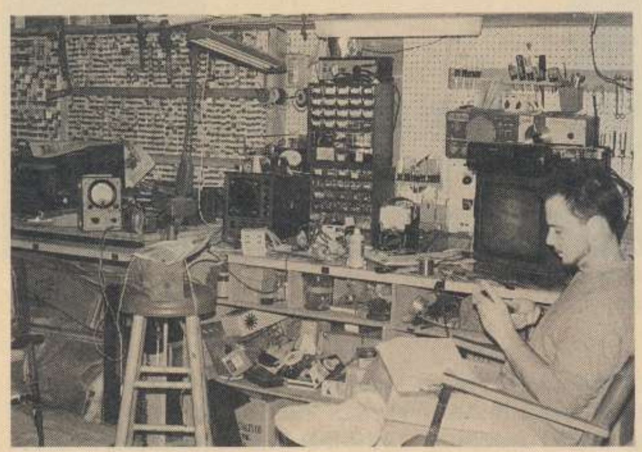
(Continued on page 89)

ANTIQUE RADIO

By Marc Ellis

Reading the Mail

It certainly seems odd to be working on our December column during the peak of the hot, muggy July weather here at my Midwest location. And, although we've been fortunate enough not to be involved in the flooding that has devastated neighboring areas, the discomfort level has been quite high. High enough, in fact, to have robbed me of inspiration for a new topic to discuss this month. Luckily, however, the ever-dependable mailbag contains some interesting letters that have been awaiting attention. So let's get right to them!.



Bob Wondoloski-Eaton in his cluttered-but-cozy workshop.

DELAYED CONTEST ENTRANT

Why don't we start with *Bob Wondoloski-Eaton* (R.D. 4 Box 432, Lewis Road, West Pittston, PA 18643), who submitted an entry to our "With the Collectors" contest two years or so after the winners were announced and the prizes distributed! Bob's reason for being late was in keeping with the spirit of the contest, which was to find out something about how the antique-radio buff integrates his (or her) hobby activities into everyday family life.

Bob writes that he wasn't able to contact me before because he's been busy remodeling the kitchen and living room. Now that those rooms are done, according to the terms of a deal cut with his wife, he is free to go ahead and remodel another room to house his growing collection of antique radios.

Bob became interested in collecting through repairing old radios for friends. About three years ago, he encountered a Zenith pushbutton console that intrigued him enough to start his own collection—and he's been at it ever since. In addition to the broadcast sets he's acquired, Bob has picked up a couple of tube testers and some military equipment.

With his letter, Bob included some nice shots, including a few of the newly remodeled rooms (which look quite sharp) and a couple of others that I'm running in the column. One shows this gentleman amid the organized chaos of his workshop; the other shows a Zenith table model (model number seems to be ES220Y) for which a schematic is needed. Contact Bob directly if you can help.

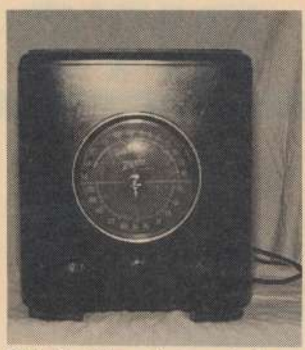
Incidentally, *Tony Schwartz*, who sent me a bunch of good pictures during that contest (and won an honorable mention), has enjoyed seeing them in print from time to time. Here's another one, Tony! Good luck on the 1950's TV set and 1930's battery console that you're now restoring.

COMMUNICATIONS-GEAR FANS

I have a several more letters relating to the recently completed series of columns on the Hallicrafters Sky Buddy restoration. For instance, *Lloyd Godsey* (21401 NE Sandy Blvd. #374, Troutdale, OR 97060), who had been following the series, eventually picked up an S-20 Sky Champion (big brother of the Sky Buddy) to restore himself. Now he'd like to locate a Hallicrafters SX28, so contact him if you can help.

Reader Godsey has a copy of the Howard W. Sams *Postwar Communications Receiver Manual*, which includes service folders on major brands of communication receivers manufactured between 1946 and the early 1950's. It does not include information on the Sky Buddy or Sky Champion, which were prewar sets, but did yield service data on the Hallicrafters S40-A—which was requested by Brazilian reader *Joel Robinson* in an earlier column. Lloyd was kind enough to send the S40-A info to Johnson, and (for the cost of copying and postage) would be glad to help other readers who might need data from the book.

Harold Webster (109 Sparkey Circle, Bay, AR 72411) also likes to restore vintage ham gear and has one of the Sams manuals. He, too, will send data to anyone



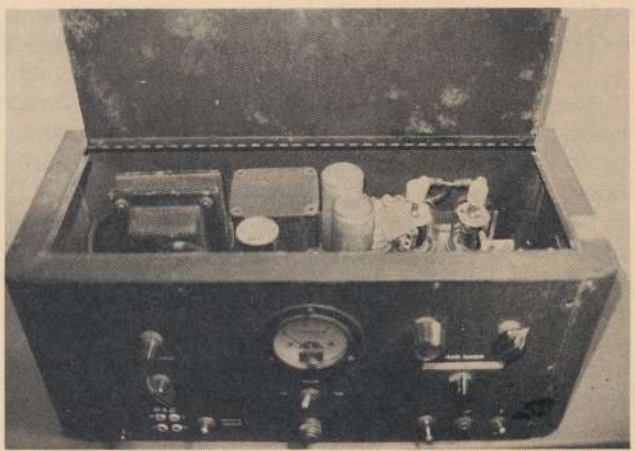
This Zenith set (seems to be model ES220Y) is Bob Wondoloski-Eaton's latest project. Can someone supply a schematic?

More sets from Tony Schwartz's collection. Top row (from left): Arvin, model unknown; Admiral 7RT42-N radio phono. Middle row: Atwater Kent 37; Zenith 7S633. Bottom row: Philco 38-120; Zenith 7C05; Silvertone 9005.

needing it for the cost of copying and postage. Reader Webster would like very much to hear from anyone who can supply data on the Conar Model 500 3-band receiver and Model 400 3-band transmitter produced by National Radio Institute about 1968–1970. NRI no longer has the info.

Reader *Ronald Messenger* was particularly interested in the column covering the Sky Buddy's realignment (May, 1993 issue). He owns some communications receivers of the same vintage and plans to acquire a signal generator so that he can work on his own radios.

Bruce Haffner (8515 W. 165 Pl., Tinley Park, IL 60477) reports that he has 1½ non-working Sky Buddy sets and is combining them to make a good one. He is also looking for copies of the series of Echophone articles that appeared in this column a few years ago. Watch these pages over the next several months, Bruce. I hope to combine, edit, and reprint certain of the more popular *Antique Radio* restoration series so that they will be available to interested readers.



Can someone help Collin Collier identify this much-modified transmitter? (See text for details).

Thanks to reader *Nestor Jose Salguerno* (Apartado 61373, Caracas, Venezuela 1060-A) for his long, chatty letter. Reader Salguerno has been hooked on antique sets since he was a child, and owns three Hallicrafters radios, including an S-120, an S-38B, and an Echophone EC-1A. He, too, would like a copy of the Echophone series.

Melvin L. Erickson, (5116 Woodhaven Dr., Flint, MI 48504) has a restored "Sky Champion" Model S-20-R. It's in very good condition, and is working fine now that he has replaced most of the capacitors. He'll be glad to copy the instruction manual for anyone that needs it. Though he didn't specify, I'd assume he'd appreciate a self-addressed stamped envelope and copying costs.

Is there a vintage-transmitter expert who can help reader *Collin Collier* (Rt. 1, 3400 Hwy. 341 S, Hawkinsville, GA 31036) identify the unit pictured? It appears to be a commercially made set that has undergone modification, some of it not very neatly done. The set has a 6AG7 crystal oscillator and a couple of 5933's in the final.

HELP WANTED

Norma M. Heatley (5855 Dixie Highway, Clarkston, MI 48346) is looking for a competent repair person to restore her 1934–35 Crosley cathedral set. She's been disappointed several times in the past, and really would like to find someone who can handle the job. Reader *George King* (7300 Denise Dr., Little Rock, AR) needs a source of schematics for a number of antique receivers. Contact him if you have the data and would be willing to make copies for a reasonable fee.

Reader *Ted Weissgerber* (1413 Gill Hall Rd., Clairton, PA 15025) restored an RCA Radiola 18 for a friend. It works fine but he's worried about the tubes, which don't light up brightly. Don't be concerned, Ted. Tubes of the type used in early plug-in radios such as the Radiola 18 tend to look dim.

Perhaps someone could write and advise Ted about his other problem: stabilizing (or replacing) the fragile grill cloth on that radio's Model 103 loudspeaker—the one with the embroidered flower arrangement. I know that I once read about a very serious restorer who had some of those grill cloths made up in Taiwan or China, and was going to make them available for sale.

Reader *Ben Myers* (Lanham, MD) wonders why the area between 8 and 9 MHz on the dial of his Majestic model 3SC80 is marked "Television Audio." Well, Ben, the early experimental TV programs were broadcast on shortwave rather than on VHF and UHF as is today's practice. Picture and sound used separate channels, and the practice apparently was to send the audio in the 8–9-MHz band.

Can someone assist *Gerard Szaulis* (4420 6th Ave., Edson, Alta., T7E 1B6 Canada) with an instruction

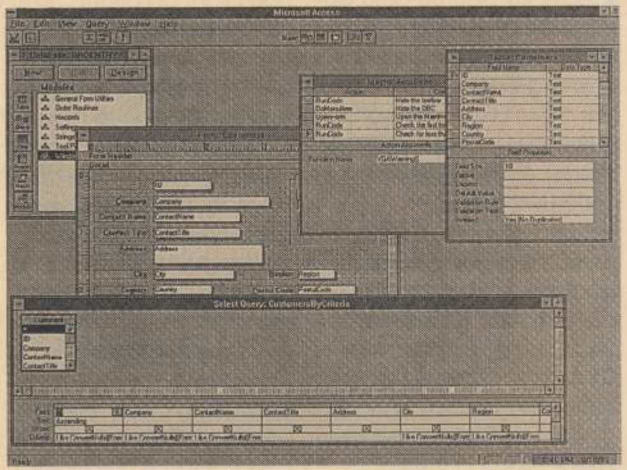
(Continued on page 90)

COMPUTER BITS

By Jeff Holtzman

The Centaur Of The Information Age

There is a common and insidious misconception that user-interface design (UID) consists merely of artfully arranging predefined screen elements in symmetrical patterns with pleasing colors. Nothing could be farther from the truth. Have you ever been fooled by a program built around an attractive screen that, nonetheless, was difficult to use?



While today's graphical-programming tools allow the design of powerful, easy-to-use packages like Microsoft's Access, graphics alone do not guarantee a good human/machine interface.

Pleasing patterns and colors may be necessary, but they're certainly not sufficient—not by a long shot. To think that that's all there is trivializes a subject that has engaged our brightest researchers and developers for more than three decades, and that has also spawned several infamous lawsuits (*e.g.*, Lotus vs. Borland, Apple vs. Microsoft/HP).

You can see the same type of phenomena everywhere; *e.g.*, handheld remote controls where you always hit the volume button when you mean to change channels, and answering machines that require you to press a hidden button to perform a common action such as erasing current messages. How about feeding paper—worse, labels—worse yet, preprinted forms—into a dot-matrix printer? This wider area falls under a field of study variously called "human factors and ergonomics."

User-interface design is traditionally viewed as the subset of human factors that is specifically concerned with the human-computer interface. Unfortunately, that view casts the problem in a prejudicial framework defined by two static entities (the user and the computer) as if the user were another entity in the category of things like modems, mice, monitors, printers, and keyboards that attach to a computer through some interface.

Modern thinking casts the problem in totally different terms, in which hardware is subsumed to the real problem: *U*ser *I*nteraction *D*esign (UID). UID focuses on *how* rather than *what*, and on *processes* rather than *mechanisms*. UID involves creating processes for interacting with a computer; out of those processes fall requirements for mechanisms—mice, graphics screens—that facilitate the processes.

Other types of requirements fall out as well. Sequencing requirements (*e.g.*, put car in gear before engaging clutch), "mode" requirements (*e.g.*, draft vs. proof quality), metaphorical requirements (*e.g.*, computer as filing cabinet, computer as ledger book), representational requirements (*e.g.*, monochrome vs. color, 2D vs. 3D, etc.), and more.

In the end, UID involves creating a "virtual" or "cyber" space in which the user can perform tasks transparently. Transparently means with little or no conscious knowledge of the process of tool usage, like writing by hand or riding a bike. Cyberspace is an abstract representation of something that may or may not exist physically. Inexperienced users typically need UID's that closely mimic a physical device, for example, a typewriter or a columnar pad. But as user sophistication increases, the "cyber" representation itself becomes reality. (Think of a desktop publishing program.)

The intensity of experience in cyberspace is directly proportional to the degree of transparency involved in navigating and operating in that space. Watch dedicated video-game players, desktop publishers, or programmers for examples of transparent experience.

To persons in those situations, there is no human-computer interface; there is no interface at all. In those situations, man and machine meld into a single, co-responsive entity, the Centaur of the information age. You've probably played a video game or two; do you ever get that kind of feeling when operating your favorite word processor? Probably not—but I bet you could.

REFERENCES

The Media Lab, Stewart Brand, Viking 1987. A visionary description of advanced research at MIT, some of which is even now coming to fruition.

The Art of Human-Computer Interface Design, edited by Brenda Laurel, Addison-Wesley, 1990. Lots of papers and examples from researchers at Apple, PARC, etc.

Designing the User Interfaces, Ben Schneiderman, Addison Wesley, 1987. Lots of background and practical advice from a leading authority.

Learning with Interactive Multimedia, edited by Sueann Ambron and Kristina Hooper of Apple, Microsoft Press, 1990

Computers as Theater, Brenda Laurel, Addison-Wesley. Applies Aristotle's theory of drama to the design of what might be called the collaborative user interface (CUI). Microsoft's "Wizards" (seen in Excel 4.0 and Access 1.0) and the "Cue Cards" in Quicken are crude attempts in this area.

The Design of Everyday Things, Donald Norman, Doubleday, 1988. A broad view of the human-factors field with plenty of practical examples covering everything from door handles to keyboards. (Formerly published as The Psychology of Everyday Things.)

THE COMPUTER AND THE WIMP

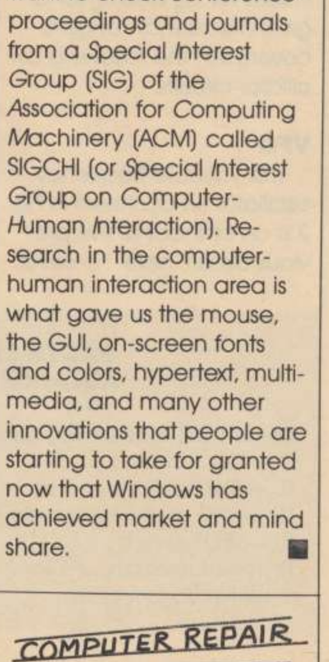
The ability to create effective user-interaction designs depends on three things:

- deep comprehension of machine capabilities,
- deep comprehension of what users want to do, and
- the ability to find the optimal compromise among machine capabilities, user needs, available development time, and cost.

By itself, the fact that a piece of software uses WIMP elements (*W*indows, *I*cons, *M*enus, *P*ointing devices) means nothing. It is just as easy to build a poor user interface with a WIMP/GUI as with a command-line interface like DOS or UNIX. And with tools like Visual Basic, it is even easier.

Neither Windows nor Macintosh (nor Motif, Openlook, GeoWorks, or anything else you may have seen) represents the pinnacle of UID. Things are going to change a lot in the next few years, even more so than in the past few years. Computer technology is still undergoing extremely rapid evolution. Today's 486 and Pentium processors are just now becoming able to handle the rich data types that are the hallmark of the kinds of user interfaces that we will eventually end up with.

For more information, the sidebar lists several books that I've found informative in this area. You may also want to check conference proceedings and journals from a *S*pecial *I*nterest *G*roup (SIG) of the *A*ssociation for *C*omputing *M*achinery (ACM) called SIGCHI (or *S*pecial *I*nterest Group on *C*omputer-*H*uman *I*nteraction). Research in the computer-human interaction area is what gave us the mouse, the GUI, on-screen fonts and colors, hypertext, multimedia, and many other innovations that people are starting to take for granted now that Windows has achieved market and mind share. ■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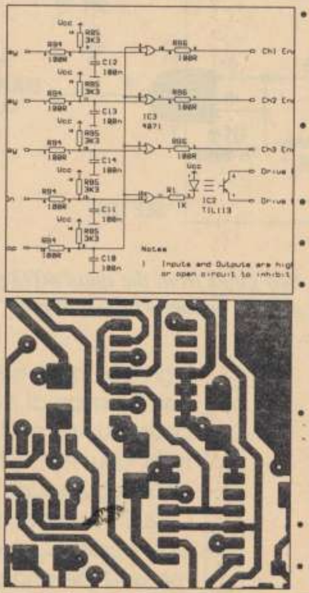

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CIRCUIT CIRCUS

By Charles D. Rakes

Plenty Of Oscillators

In this month's Circus, we're going to present several simple but interesting circuits, all of which are based on a single chip—the 4093 CMOS quad 2-input NAND Schmitt trigger, a special NAND gate that is ideally suited for use with slow-changing or noisy input signals.

ASTABLE OSCILLATOR

Our first circuit (see Fig. 1) uses two gates from the quad 4093 package to form a simple astable squarewave oscillator. Actually, the first gate functions as the oscillator and the second serves to buffer the output signal. When power is applied to the circuit and S1 is placed in the RUN position, pin 1 of U1-a is high and pin 2 is low. That combination of inputs causes U1-a's output to go high, causing C_X to begin charging through R_X.

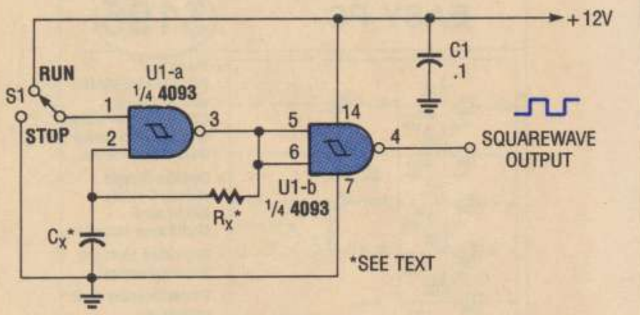

Fig. 1. In this circuit, two gates from the quad 4093 package are used to form a simple astable squarewave oscillator.

As C_X charges, the voltage across C_X continues to rise until the charge reaches U1-a's high input-trigger voltage, causing its output to swing low. The capacitor discharges until the gate's low-input threshold level is reached. That causes U1-a's output to change states, causing the sequence to repeat. That cycling effect (oscillation) is caused by the difference in the IC's high- and low-gate threshold points.

The circuit's operating frequency (which can range up to about 1 MHz) is determined by the values of C_X and R_X. The value of C_X can be varied from a few picofarads to several microfarads as long as its internal leakage current is very low. The value of R_X can range anywhere from a few thousand ohms to more than several megohms. More information on selecting values for C_X and R_X for a given frequency range is covered in the following oscillator circuits.

VFO

The variable-frequency oscillator (VFO) shown in Fig. 2 is an offshoot of the previous circuit; here, however, the operating frequency is controlled by C1 (a variable tuning capacitor). The circuit can provide an output frequency ranging from 115 Hz to over 40 kHz. The lowest frequency range (see the chart in Fig. 2) is obtained with the largest resistance value. The lowest frequency in all frequency ranges is obtained when C1 is set to its maximum capacitance value. The oscillator's frequency stability is excellent.

The tuning capacitor may be kind of hard to come by from conventional sources, however it can usually be obtained from local hamfests or scrounged from an old tube-type AM radio. If all else fails, check with some of the old timers at local ham clubs. Tuning capacitors are out there if you look hard enough. The one I used was an old 3-gang type that provided a total capacitance of about 1000 pF (0.001-µF) when all of its sections were paralleled. If you can't locate a 2- or 3-gang unit, you can get by with a single 365-pF variable capacitor and two 330-pF fixed units.

The two switches (S3 and S4) are used to switch additional capacitance (C4 and C5, a pair of 330-pF units) into and out of the circuit. The lower three frequency ranges shown in the chart were obtained by adding a fixed 100-pF capacitor across C1. Adding that fixed capacitor to the circuit reduced C1's tuning range, but offers the advantage of making it easier to set the oscillator to the desired frequency.

PARTS LIST FOR THE ASTABLE OSCILLATOR

C1—0.1-µF, ceramic-disc capacitor
C_X—See text
R_X—See text
U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit
S1—SPDT switch
Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

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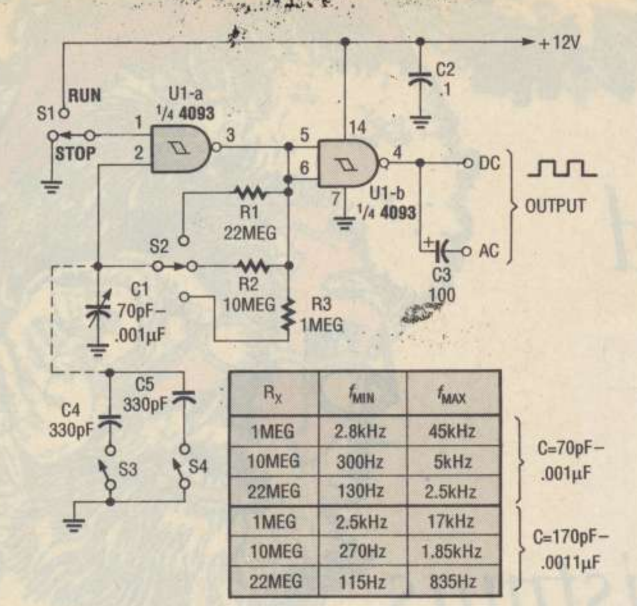


R_X	f_{MIN}	f_{MAX}	
1MEG	2.8kHz	45kHz	C=70pF– .001µF
10MEG	300Hz	5kHz	
22MEG	130Hz	2.5kHz	
1MEG	2.5kHz	17kHz	C=170pF– .0011µF
10MEG	270Hz	1.85kHz	
22MEG	115Hz	835Hz	

Fig. 2. This variable-frequency oscillator (VFO) is an offshoot of the previous circuit; however, this circuit has a variable (via C1) operating frequency.

PARTS LIST FOR THE VFO

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1—22-megohm

R2—10-megohm

R3—1-megohm

CAPACITORS

C1—70-pF–0.001-µF, variable (see text)

C2—0.1-µF, ceramic-disc

C3—100-µF, 25-WVDC, electrolytic

C4, C5—330-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit

S1—SPDT switch

S2—SP3T switch

S3, S4—SPST switch

Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

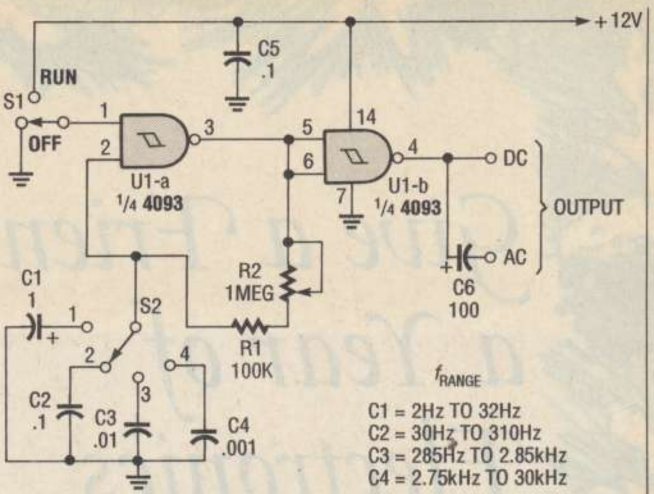


Fig. 3. The circuit shown here (another VFO) reverses the roles of R_X and C_X; e.g., the oscillator's frequency is varied by adjusting R2 and its frequency range is determined by selecting a timing capacitor via S2.

PARTS LIST FOR ANOTHER VFO

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)

R1—100,000-ohm

R2—1-megohm linear potentiometer

CAPACITORS

C1—1.0-µF, Mylar

C2—0.1-µF, Mylar

C3—0.01-µF, Mylar

C4—.001-µF, Mylar

C5—0.1-µF, ceramic-disc

C6—100-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit

S1—SPST switch

S2—SP4T switch

Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

ANOTHER VFO

Our next circuit is another VFO (see Fig. 3). That circuit, however, reverses the roles of R_X and C_X; *e.g.*, the oscillator's frequency is varied by adjusting R2 and its frequency range is determined by selecting a timing capacitor via S2. At this juncture, you might be wondering why use a variable capacitor, as in the previous circuit, if it's so easy to obtain similar results with an easy-to-get potentiometer? The main purpose of using the variable capacitor (at least in this column) is to help illustrate the flexibility of the 4093 and to offer another method of frequency control.

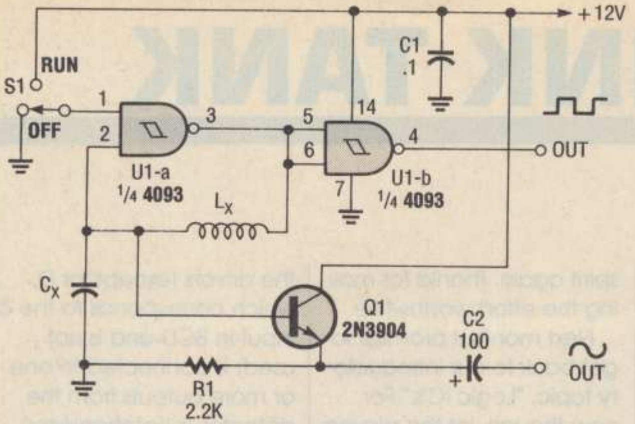
The oscillator circuit in Fig. 3 has four frequency ranges: position 1 has a frequency range of from 2 Hz to 32 Hz; position 2 from 30 Hz to 310 Hz; position 3 from 285 Hz to 2.85 kHz, and position 4 from 2.75 kHz to 30 kHz.

SINEWAVE OSCILLATOR

Squarewaves are nice, but there are times when a sinewave oscillator is useful. The circuit in Fig. 4 shows just how simply that can be accomplished. By replacing R_X of the previous circuit with an inductor, the simple squarewave oscillator turns into a nice little sinewave generator. Several capacitor and inductor values along with their expected frequencies are also given in Fig. 4; those values can be used as a guide in selecting components for a desired frequency.

RANGE SWITCH

Our next circuit (see Fig. 5) shows how easy it can be to electronically switch the oscillator's frequency range. In this circuit, a 2N3904 NPN transistor (Q1) is used as a simple switch that places a second capacitor (C2) in parallel with the circuit's timing capacitor (C1). When S1 is placed in the LOW FREQ. position, a positive voltage is applied to the base of Q1, causing it


+12V
C1
.1
RUN
S1
OFF
1
2
3
U1-a
1/4 4093
5
6
14
4
7
OUT
U1-b
1/4 4093
L_X
C_X
Q1
2N3904
C2
100
OUT
R1
2.2K

C_x	L_x	f_{OUT}
.018	50mH	9kHz
.018	2mH	14kHz
.047	5mH	5.5kHz
1	1H	300Hz
1	10H	100Hz

*SEE TEXT

Fig. 4. By substituting an inductor (L_X) for R_X of the previous circuit, the simple squarewave oscillator becomes a sinewave generator.

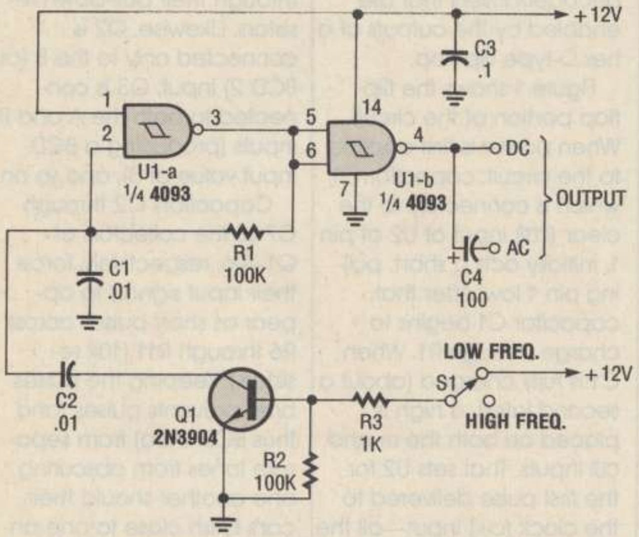

+12V
C3
.1
1
2
3
U1-a
1/4 4093
5
6
14
4
7
DC
U1-b
1/4 4093
OUTPUT
AC
C4
100
R1
100K
C1
.01
C2
.01
Q1
2N3904
R2
100K
R3
1K
LOW FREQ.
S1
+12V
HIGH FREQ.

Fig. 5. The operating frequency of our oscillator circuits can be altered by adding the transistor-switch portion (Q1, R2, R3, and S1) of this circuit.

to turn on, pulling its collector to ground. That places C2 in parallel with C1, thereby increasing the effective timing capacitance, which in turn lowers the oscillator's operating-frequency range.

If S1 is flipped to the HIGH FREQ. position, Q1 turns of, removing C2 from the timing circuit. Removing that capacitor decreases the oscillator's effective timing capacitance, thereby raising the oscillator's operating-frequency range.

Although the transistor circuit was designed to be driven by the output of a CMOS gate, a mechanical switch (S1) is shown to illustrate how the circuit operates. The transistor switch can be used with both the squarewave and sinewave oscillators shown earlier.

PARTS LIST FOR THE SINEWAVE OSCILLATOR

SEMICONDUCTORS

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit
Q1—2N3904 general-purpose NPN silicon transistor

CAPACITORS

C1—0.1-µF, ceramic-disc
C2—100-µF, 25-WVDC, electrolytic
C_X—See text

ADDITIONAL PARTS AND MATERIALS

L_X—See text
S1—SPST switch
R1—2200-ohm, ¼-watt, 5% resistor
Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

PARTS LIST FOR THE RANGE SWITCH

SEMICONDUCTORS

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit
Q1—2N3904 general-purpose NPN silicon transistor

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R2—100,000-ohm
R3—1000-ohm

CAPACITORS

C1, C2—0.01-µF, ceramic-disc
C3—0.1-µF, 50-WVDC, ceramic-disc
C4—100-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—SPST switch
Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

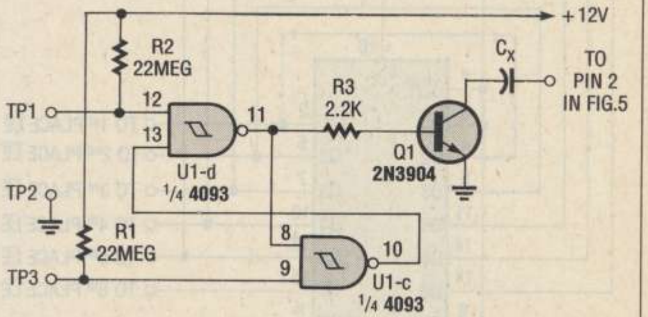

+12V
R2
22MEG
TP1
12
13
11
U1-d
1/4 4093
R3
2.2K
C_X
TO
PIN 2
IN FIG.5
Q1
2N3904
TP2
R1
22MEG
TP3
8
9
10
U1-c
1/4 4093

Fig. 6. This circuit uses two NAND Schmitt triggers connected in a flip-flop configuration to produce a bridged touch-activated switch. The switch can replace the range-switching portion (Q1, R2, R3, and S1) of the circuit in Fig. 5.

BRIDGED TOUCH SWITCH

Our next circuit (Fig. 6) uses two NAND Schmitt-triggers, connected in a flip-flop configuration, to produce a bridged touch-activated switch, which can replace the range-switching portion (Q1, R2, R3, and S1) of the Fig. 5 circuit.

(Continued on page 90)

THINK TANK

By John J. Yacono

Derby Finale

We are now at the end of our pinewood derby exhibition. This month we'll present the last quality pinewood-derby circuits that made it in on time. The contributors will be rewarded with a *Think Tank II* book and, as a bonus for taking part in our derby mania, MCL1010 chips.

With regard to the pinewood-derby contributors, I say a hearty thank you. As it turns out, although they required more work on the part of the entrants, I received more pinewood-derby circuits than any prior specially requested submissions! You've probably helped a lot of community organizations, and, if nothing else, gave some of us a feeling of community spirit again. Thanks for making the effort worthwhile.

Next month, I promise to get back to our introductory topic, "Logic IC's." For now, though, let the players take the field . . . .

MULTIPELXED DERBY

Regarding the request from Stephen Guye about a circuit for a six-lane race judge, I think I have just the thing. The circuit consists of six 7-segment displays (one per lane) that are driven by six BCD-to-7-segment latch/decoder/drivers that are enabled by the outputs of a hex D-type flip-flop.

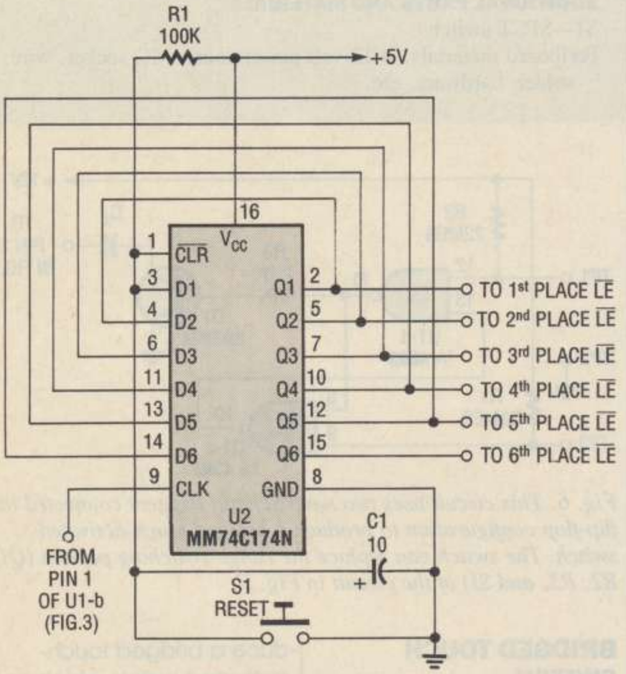
Figure 1 shows the flip-flop portion of the circuit. When power is first applied to the circuit, capacitor C1, which is connected to the clear ($\overline{\text{CLR}}$) input of U2 at pin 1, initially acts a short, pulling pin 1 low. After that, capacitor C1 begins to charge through R1. When C1 is fully charged (about a second later), a high is placed on both the D1 and $\overline{\text{CLR}}$ inputs. That sets U2 for the first pulse delivered to the clock (CLK) input—all the outputs are cleared (low) and there is a high waiting at the D1 (pin 3) input.

Notice from the display section (shown in Fig. 2) that all the binary inputs of the six 4511 display drivers (only one is shown) have their like inputs connected together and tied to ground through four pull-down resistors (R2–R5). Those resistors cause the display drivers to initially show a 0 on each display.

Notice also from the detector diagram (in Fig. 3) that each binary input on the drivers (except for D, which corresponds to the 8 input in BCD and is not used) is connected to one or more outputs from the detector (phototransistor) circuits. If you follow the lines leading from the collector of each phototransistor, you'll see that Q1 is connected to the A input(s) only. That means that when Q1 is triggered, the display driver that is latched will only receive a BCD 1 since all the other inputs are tied to ground through their pull-down resistors. Likewise, Q2 is connected only to the B (or BCD 2) input, Q3 is connected to both the A and B inputs (producing a BCD-input value of 3), and so on.

Capacitors C2 through C7 at the collectors of Q1–Q6, respectively, force their input signals to appear as short pulses across R6 through R11 (10k resistors). Keeping the pulses brief prevents pulses (and thus BCD data) from separate lanes from obscuring one another should their car's finish close to one another. Those pulses are fed to the input of U1-a and, through U1-b, and then fed to the clock (CLK) input of U2 (back in Fig. 1).

Phototransistors Q1 through Q6, which are placed on the track and receive normal room lighting, are switched on by that light and effectively connect each of the 1.5k resistors (R6 through R11) to ground. The low keeps the display-driver inputs from receiving a pulse that would change their state until a car passes, blocking



R1
100K
+5V
16
1
$\overline{\text{CLR}}$
V_{CC}
3
D1
4
D2
6
D3
11
D4
13
D5
14
D6
9
CLK
Q1
Q2
Q3
Q4
Q5
Q6
GND
2
5
7
10
12
15
8
TO 1st PLACE $\overline{\text{LE}}$
TO 2nd PLACE $\overline{\text{LE}}$
TO 3rd PLACE $\overline{\text{LE}}$
TO 4th PLACE $\overline{\text{LE}}$
TO 5th PLACE $\overline{\text{LE}}$
TO 6th PLACE $\overline{\text{LE}}$
U2
MM74C174N
C1
10
+
FROM
PIN 1
OF U1-b
(FIG.3)
S1
RESET

Fig. 1. This hex flip-flop indirectly receives clock pulses from the dark detectors and activates each place-display circuit one at a time. Components R1 and C1 initially set-up the flip-flop and those components can be reactivated by depressing S1 to initialize the flip-flop for future races.

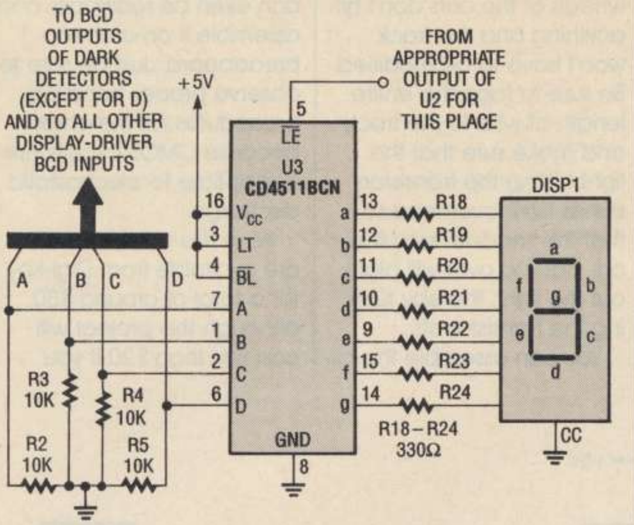

TO BCD OUTPUTS OF DARK DETECTORS (EXCEPT FOR D) AND TO ALL OTHER DISPLAY-DRIVER BCD INPUTS
+5V
FROM APPROPRIATE OUTPUT OF U2 FOR THIS PLACE
5
LE
U3
CD4511BCN
16
VCC
3
LT
4
BL
7
A
1
B
2
C
6
D
GND
8
A
B
C
D
R3 10K
R4 10K
R2 10K
R5 10K
13 a
12 b
11 c
10 d
9 e
15 f
14 g
R18
R19
R20
R21
R22
R23
R24
R18–R24 330Ω
DISP1
a
b
c
d
e
f
g
CC

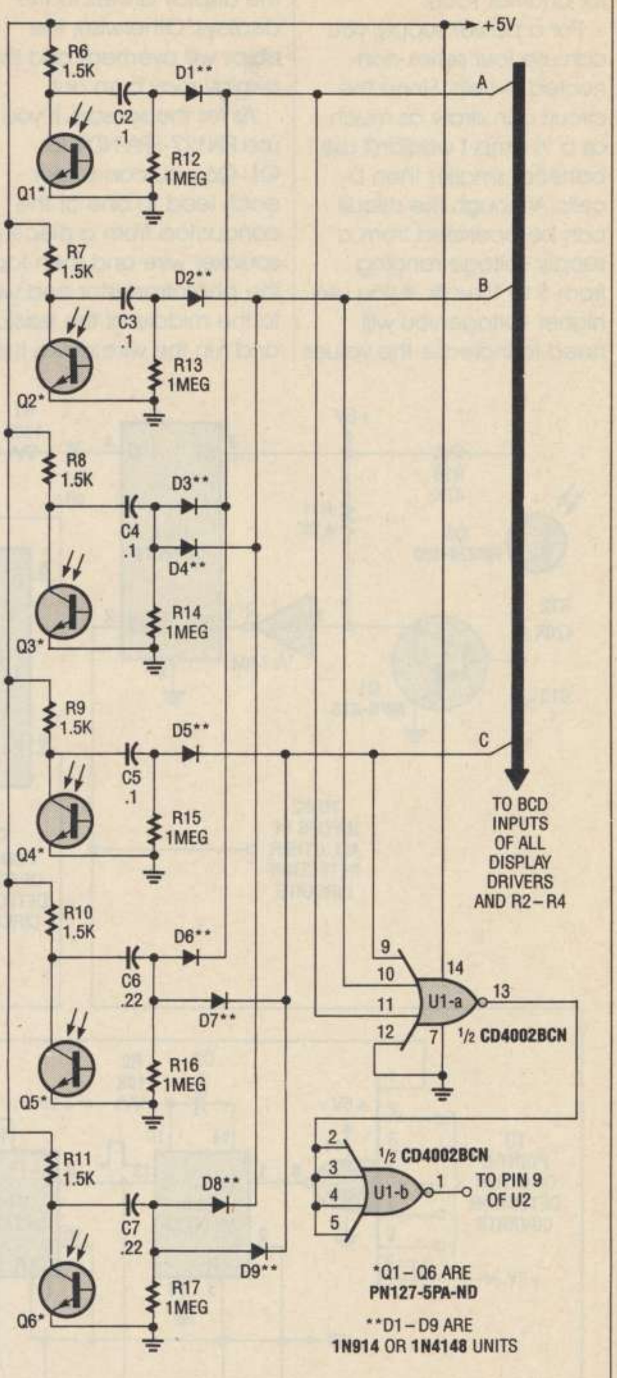
Fig. 2. Each display circuit receives BCD data from the dark-detector/BCD-encoder circuitry, but only the display circuit that is latched by U2 (in Fig. 1) will hold and display the current lane number.

the light to a phototransistor.

When a car passes over a phototransistor, it turns off, producing a high at its collector. That high is fed through its respective capacitor and diode(s), placing a high across the resistor connected to the input(s) of its respective display driver. After a very short time, the capacitor charges and the voltage across the resistor once again goes low, so the next car that comes along and turns-off a phototransistor won't experience any interference from the previous one.

Phototransistor Q1 should be placed in lane 1, Q2 goes in lane 2, and so on down the line to Q6, which is, naturally, placed in lane 6. Likewise, the displays should be placed in order; *i.e.*, display one should be placed first, display 2 second, and so on so that display six shows the car that comes in last. If that layout is followed, each display will show the lane number for the car that finished in that place.

For example, at the moment a phototransistor turns off, the capacitor at its collector begins to conduct, placing a high at one or more inputs to the display drivers and at the input to U1-a. That gate along with U1-b forms a 3-input OR gate, so they apply the high to the clock input of U2. Integrated circuit U2 then places the value of the D1 input on its Q1 output (see Fig. 1). Since D1 is high, the Q1 output of U2 goes high. Each output of U2 is connected to a latch-enable input on one of the display drivers, so that when the Q1 output goes high, it latches the data on the first-place display-driver's inputs. The Q1 output is also connected to U2's D2 input, so that when the first-place display is latched, a high is placed on the next data input (D2) of U2, readying it for the next car to block a phototransistor and simultaneously place data at the inputs of the display drivers while clocking U2 to latch the next display.


+5V
R6 1.5K
D1**
C2 .1
R12 1MEG
Q1*
R7 1.5K
D2**
C3 .1
R13 1MEG
Q2*
R8 1.5K
D3**
C4 .1
D4**
R14 1MEG
Q3*
R9 1.5K
D5**
C5 .1
R15 1MEG
Q4*
R10 1.5K
D6**
C6 .22
D7**
R16 1MEG
Q5*
R11 1.5K
D8**
C7 .22
D9**
R17 1MEG
Q6*
A
B
C
TO BCD INPUTS OF ALL DISPLAY DRIVERS AND R2–R4
9
10
11
12
14
7
U1-a
13
1/2 CD4002BCN
2
3
4
5
U1-b
1
1/2 CD4002BCN
TO PIN 9 OF U2

*Q1–Q6 ARE **PN127-5PA-ND**

D1–D9 ARE **1N914 OR **1N4148** UNITS

Fig. 3. The two 4-input NOR gates are used to OR the output of all the dark detectors to produce a clock pulse when each car crosses the finish line. The output of each detector is BCD-encoded by the diodes in order to transcribe its lane number onto the display-driver bus.

After the race, the circuit can be reset by pushing S1, a normally open momentary-contact switch. When S1 is pushed, the D1 and $\overline{\text{CLR}}$ inputs of U2 go low long enough to clear the flip-flop outputs. When the outputs go low, the displays are no longer latched, and once again they display zero data at their BCD inputs, and the track is ready for another race.

For a power supply, you can use four series-connected D-cells. Since the circuit can draw as much as a ½ amp, I wouldn't use batteries smaller than D-cells. Although the circuit can be operated from a supply voltage ranging from 5 to 15 volts, if you use higher voltage you will need to increase the values of the resistors that connect the display drivers to the displays. Otherwise, the chips will overheat and the display may burn out.

As for the sensors, if you use PN127-SPA-ND's for Q1–Q6, you can solder each lead to one of the conductors from a piece of speaker wire and then tape the phototransistor and wire to the middle of the track, and run the wire down the center of track so that the wheels of the cars don't hit anything and the track won't have to be modified. Be sure to tape the entire length of wire to the track and make sure that the light hitting the transistors shines from overhead so that the shadow from the car passing over will block out the light, thereby turning the transistor off.

You can assemble the circuit any way you like. You can even be really lazy and assemble it on a cheap breadboard. Just be sure to observe proper handling procedures for the chips because CMOS circuits are susceptible to electrostatic discharge.

All of the components are available from Digi-Key for a total of around $30, although the project will cost less than $20 if you

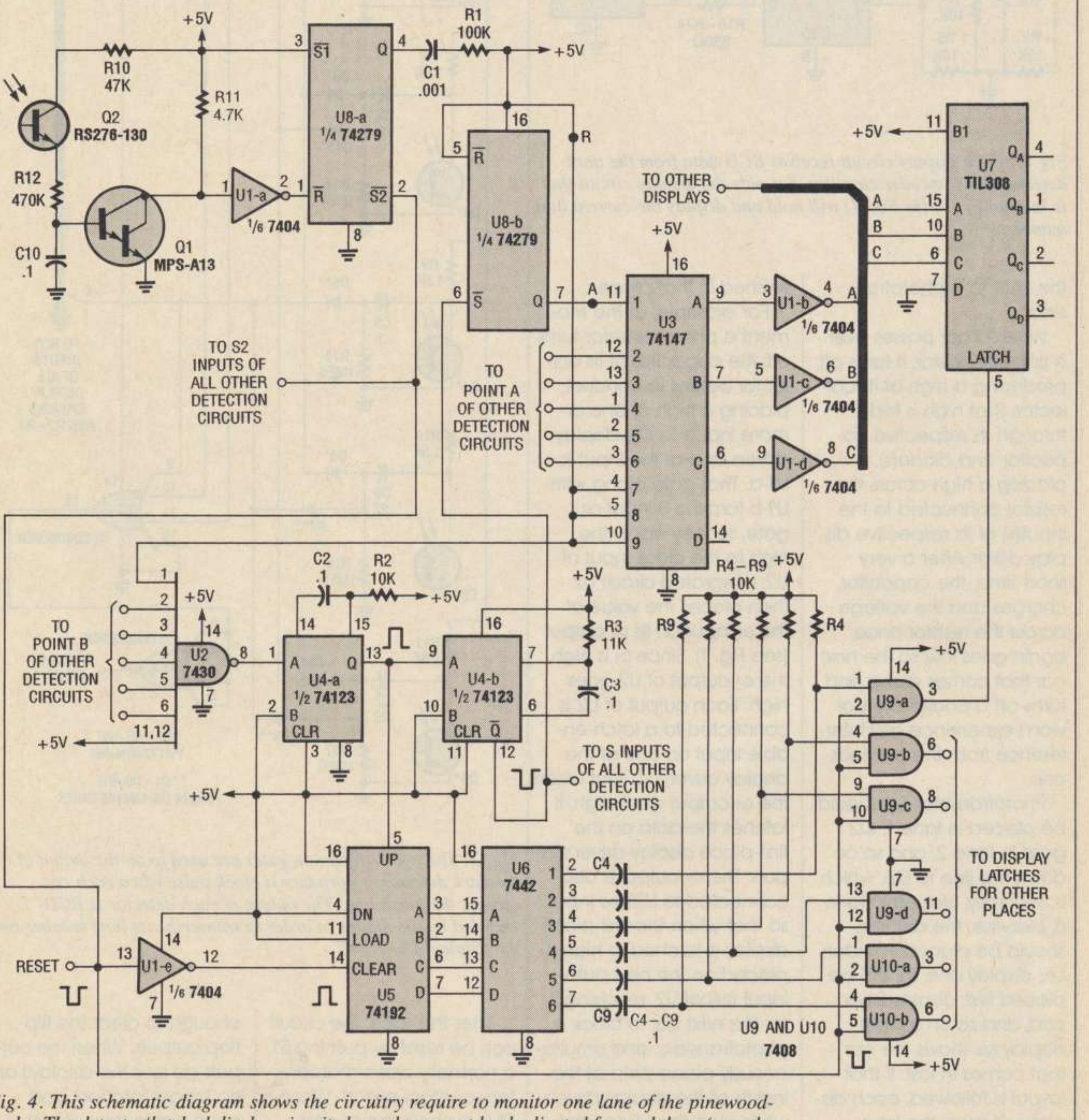

+5V
R10
47K
R11
4.7K
Q2
RS276-130
R12
470K
C10
.1
Q1
MPS-A13
U1-a
1/6 7404
U8-a
1/4 74279
S1
S2
R
Q
C1
.001
R1
100K
+5V
U8-b
1/4 74279
S
R
TO S2 INPUTS OF ALL OTHER DETECTION CIRCUITS
TO POINT A OF OTHER DETECTION CIRCUITS
U3
74147
U1-b
1/6 7404
U1-c
1/6 7404
U1-d
1/6 7404
TO OTHER DISPLAYS
A
B
C
D
U7
TIL308
B1
LATCH
QA
QB
QC
QD
R4–R9
10K
R9
R4
R3
11K
C3
.1
C2
.1
R2
10K
TO POINT B OF OTHER DETECTION CIRCUITS
U2
7430
11,12
U4-a
1/2 74123
U4-b
1/2 74123
CLR
TO S INPUTS OF ALL OTHER DETECTION CIRCUITS
U9-a
U9-b
U9-c
U9-d
U10-a
U10-b
TO DISPLAY LATCHES FOR OTHER PLACES
RESET
U1-e
1/6 7404
U5
74192
UP
DN
LOAD
CLEAR
U6
7442
C4
C9
C4–C9
.1
U9 AND U10
7408

Fig. 4. This schematic diagram shows the circuitry require to monitor one lane of the pinewood-derby. The detector/latched display circuit shown here must be duplicated for each lane (say, the 2nd through 6th) included in your derby-judging system.

happen to have the six displays already. You can also cut power consumption considerably by placing a transistor between each display and ground and using a clock circuit to strobe them on in turn.

—Guy Lamrouex, Sarasota, FL

You really cut down on parts by using diodes as a BCD-data generator and U2 as a shift-register style latch enable. I suppose if an octal flip-flop (or 8-bit shift register) were used in place of U2, you could take advantage of the unused display-latch inputs by adding two more lanes. Of course, the additional dark detectors would have to be appropriately multiplexed, with the last lane (number 8) connected to the unused input of U1-a.

OVER THE LINE

I was pleasantly surprised to read the call for pinewood-derby finish detectors. Years ago, a friend of mine asked me to build one because a genuine fist fight had erupted during the previous year's competition.

The first thing that I considered was how to display the results. I decided to use six 7-segment latched displays to reveal the contestants' finishing order (see Fig. 4). So the left-most display in my system indicates the lane that finished first, the display to the right of that shows the second-place winner, and so on.

Each lane's photodetector (Q2 in the schematic diagram) sets an RS flip-flop (represented by U8-a) that is unique to that lane. The flip-flop's state change is sent through a capacitor and pull-up resistor to edge trigger a second RS flip-flop (U8-b) that is connected to the lane-number input of a binary encoder (U3). After that pulse, the encoder's output-data lines contain the lane number.

The same edge-triggered pulse that sets the second flip-flop is sent to an eight-input NAND gate (U2) that triggers a very fast monostable multivibrator (U4-a). In turn, the monostable's output pulse advances a binary counter (U5) and triggers another very fast monostable (U4-b). The counter output is decoded and sent to a pulse generator that latches the display corresponding to the counter contents. The output of the second monostable is designed to allow the expiration of the latch pulse before resetting the second RS flip-flop (which is locked out until a master reset is activated). The lane number data is present on the latch data lines before the latch pulse occurs, and is stable throughout. After latching the data, the lane is locked out.

Two types of displays were used. One of the displays was based on the classic 7475, 7447, and 7-segment display arrangement (not shown). The second used the Texas Instruments TIL308 display, which has a built-in latch and 7-segment decoder, as shown.

—Kenneth J. Michael, Palos Hills, IL

Having the display list the finishing order is a nice change from the usual line-tied display. If nothing else, it allows the builder to set up a track with more lanes than there are places of merit.

That's all for now, and for the pinewood derby. Until next month, take care and send your best efforts to: *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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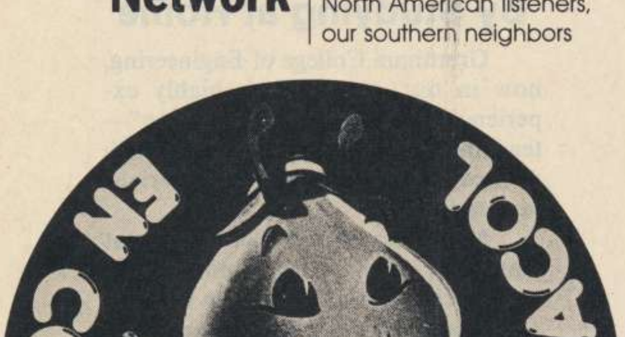
DX LISTENING

By Don Jensen

South American Radio Network

In Canada, the *CBC* feeds its programming to local and regional stations from coast-to-coast across the provinces. *ABC, NBC, CBS*, and *National Public Radio* networks are important broadcast services for American listeners. Although not well known to North American listeners, our southern neighbors have radio networks that serve a similar purpose, particularly as national news services.



This cartoon bug is the logo mascot of Columbia's CARACOL radio network.

In Colombia, for example, *CARACOL* is one of the most important radio networks, serving Spanish-speaking stations not only in that country, but elsewhere in South America as well. CARACOL, an acronym for Primera CAdena RAdial COLombiana, or "Colombia's No. 1 Radio Network," is headquartered in the Colombian capital, Bogota, but owns or is affiliated with nearly 90 AM and shortwave stations in the country. Additionally, other stations within and without Colombia carry CARACOL newscasts either regularly or occasionally.

Don Moore, writing in a recent issue of the North American SW Association's *Journal*, focused his "Latin Destinations" column on CARACOL, calling it a significant force in Latin-American news coverage. As large as CARACOL is, Moore noted, it is only one part of Grupo Santodomingo, one of three business conglomerates that control much of Colombia's economy. Grupo Santodomingo owns banks, insurance companies, petrochemical plants, a television station, a national airline, and all of Colombia's major breweries. It's also a major stockholder in the popular news weeklies *Cromos* and *Cambio 16*.

CARACOL also has a satellite hookup that allows it to serve as a news hub for the rest of Latin America. Moore notes that during the last U.S. presidential election, CARACOL picked up live-satellite news feeds from North America and relayed them to major broadcasting organizations in about a dozen South American countries.

CARACOL's shortwave outlets—broadcasting from Bogota on 5,075 and 6,075 kHz—are not difficult to hear. Those outlets operate with 25 and 50 kilowatts, respectively, making them the most powerful shortwave-broadcasting transmitters in Colombia. The 5,075-kHz channel is the most easily heard, with nightly Spanish-language programming, while 6,075 kHz may be noted during mornings. Interference can be a problem on the latter frequency, Moore says, as is the case with CARACOL Colombia's 6,150-kHz frequency, which is transmitted from Huila in southern Colombia.

Other listed CARACOL shortwave outlets include those in the Colombian cities of Bucaramanga (4,845 kHz) and Nieva (4,945 kHz). Reception reports—preferably in Spanish—may be sent to CARACOL, Apartado Aereo 9291, Bogota, D.E., Colombia.

IN THE MAIL

There are another interesting batch of letters in the box this month. If yours is not among them, why not drop us a line. Do you have questions and comments about SWL'ing? They're all welcome. The address is: *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

"A longtime SWL friend of mine," writes Frank Maurer, Dothan, AL, "always ends his letters, just before his signature, by writing the number, 73. I understand that is amateur-radio slang for ending a conversation, and roughly means goodbye and best regards. But what is the origin of 73?"

I've been aware for years, Frank, that the origin of the 73 code dates back nearly a century and a half to the early days of wire telegraphy. But, recently, a more detailed explanation appeared in *Contact*, the publication of the "World DX Club." It quotes a ham-radio researcher, Louise Ramsey Moreau, as saying the first authenticated use of 73 appeared in *The National Telegraphic Review and Operators' Guide*, which was first published in 1857. The purpose of that and other number codes was to serve as a sort of shorthand for regularly used and common phrases. It took far fewer strokes on the telegrapher's key to transmit a number or two than it did to laboriously tap out all the letters in the words that made up the phrase.

Originally, Moreau indicates, 73 stood for "My love to you!" But soon telegraphers were using that two-digit signal simply as a friendly greeting to fellow operators at the end of a message transmission. That usage was recognized by the National Telegraph Convention. But in 1859, when the Western Union Co. set up a standard list of numbers—1 to 92—to indicate a series of prepared phrases to be used by telegraphers, the meaning of 73 was listed as "accept my compliments."

The *20th Century Manual of Railroad and Commercial Telegraphy* gave the meaning of 73 as "My compliments to you." By 1908, *Dodge's Telegraph Instructor* said that the numerals meant "Best regards." And when the first wireless experimenters, who similarly used Morse code, came along, they adopted both the number 73 and that meaning. Morse code, of course, seems very dated in this age of fiber-optic transmission and satellite communications.

Still, Morse code survives among both amateur and professional radio operations. In fact, for those who remained hooked on Morse code, there is a bimonthly magazine that is published in England and devoted to the code's past, present, and future. Archaically entitled *Morsum Magnificat*, the magazine includes news and commentary on the use of Morse code today, tips for good operating, information on keys and equipment, data about clubs for Morse-code enthusiasts, and even a bit of *di-dah* humor and poetry.

For information about subscriptions, write to (include a self addressed, stamped envelope) Morsum Magnificat's North American agent, Wise Owl Worldwide Publications, 4314 West 238th St., Torrance, CA 90505, or call 310-375-6258.

ADDRESSING A PROBLEM

Next we have a suggestion from a young man who describes himself as "a 13-year-old SW enthusiast." He indicates that he lives on a rural Star Route near Jim Thorpe, PA; unfortunately, he forgot to sign his letter. Our unknown SWL says that he'd like to see more station addresses in *DX Listening* to make it easier to send reception reports and, hopefully, receive the stations' QSL cards in return.

For starters, he offers the following:

- *Israel Radio*, P.O. Box 1082, Jerusalem, Israel.
- *Voice of Free China*, P.O. Box 22-38, Taipei, Taiwan.
- *Radio Finland*, P.O. Box 10, 00241 Helsinki, Finland.
- *UAE Radio*, P.O. Box 63, Abu Dhabi, United Arab Emirates.

Thanks, Mr. X, and next time, don't forget your name. And speaking of QSL's, Klaus Spies, Niles, IL, writes to note that as far as he's concerned, the practice of collecting verifications (he's both and SWL and a licensed ham, WB9YBM) is alive and well.

"In ham radio," Klaus says, "QSL'ing still is considered the final courtesy after a contact with another ham," but he notes that some hams have cut back on QSL's for much the same reason as have some of the international SW broadcasters, "the cost of sending them."

DOWN THE DIAL

This month we'll focus on various relay transmitters around the world that have been logged recently.

ANTIGUA—9,670 kHz. Germany's *Deusche Welle* is relayed from this West Indian island during the evening hours. Look for it in English from around 0458 UTC, with its interval signal and identification.

CANADA—11,715 kHz. *Radio Canada International*'s broadcasting facilities are used to relay the English programming of *Radio Korea* on this frequency at 1045 UTC.

FRENCH GUIANA—11,680 kHz. Another South American relay sends along the English-language programming of Beijing's *China Radio International* at around 0400 UTC.

KAZAKHSTAN—12,025 kHz. The English-language programs of *Radio Nederland* noted on this frequency at 0130 UTC are reportedly relayed from former Soviet transmitters at Alma Ata. ■

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*Credits: Ralph Brandi, NJ; Mikell Goetsch, PA; Marie Lamb, NY; Doug Robertson, CA; Chris Tyle, LA; North American SW Association, 45 Wildflower Rd., Levittown, PA 19057; World DX Club, c/o Richard D'Angelo, 2216 Burkey Dr., Wyomissing, PA 19610.

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CIRCLE 159 ON FREE INFORMATION CARD

HAM RADIO

By Joseph J. Carr, K4IPV

Amateur Radio and Science Fairs

All over the country this Fall, students have been selecting science-fair projects. As a veteran science-fair judge, I am encouraged by the increase in the number of youngsters doing science-fair projects, and also by their quality. Unfortunately, I am also disheartened by the lack of radio projects, ham radio included. If at this late date, you are still looking for project ideas, I have a suggestion: solar and ionospheric observations. They are easily made with basic ham/SWL receivers, as well as simple homebrew VLF receivers. We will get into a few specifics a little later in this column. But first, lets see how solar and atmospheric conditions can effect radio communications.

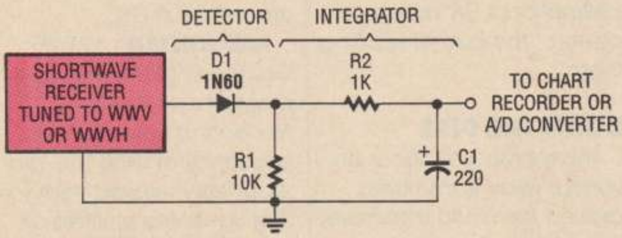

DETECTOR
INTEGRATOR
SHORTWAVE RECEIVER TUNED TO WWV OR WWVH
D1
1N60
R2
1K
TO CHART RECORDER OR A/D CONVERTER
R1
10K
+
C1
220

Fig. 1. Eighth-grader Jennifer Lieber of Florida (a science fair winner) used a circuit similar to this one to monitor solar-flare activity by observing WWV signals.

SKIP COMMUNICATION

Radio "skip" communication is directly related to the activity of the Sun. There are several different forms of Sun activity that affect radio propagation and are seen on a regular basis: they are diurnal, 27-day (monthly), seasonal, and 11-year cycle.

Diurnal (daily) variation: The Sun rises and falls on a 24-hour cycle, and because it is a principal source of ionization of the upper atmosphere one can expect diurnal variation. During daylight hours E and D levels exist in the ionosphere, but those layers disappear at night. The height of the F2 layer increases until midday, and then decreases until evening when it disappears altogether or merges with other layers. As a result of higher absorption in the E and D layers, lower frequencies are not useful for skip during daylight hours. On the other hand, the F layers reflect higher frequencies during the day. In the 1- to 30-MHz region, higher frequencies (greater that 12 MHz) are used during daylight hours and lower frequencies (less than 12 MHz) at night.

27-Day Cycle: Approximately monthly, this variation is cause by the rotational period of the Sun. Sunspots, which can effect radio communications, are localized on the surface of the Sun and as such face the Earth only during a portion of the month. As new sunspots are formed, they do not show up on the earthside face until their region of the Sun rotates to face the Earth.

Seasonal Cycle: The Earth's tilt varies the exposure of the planet to the Sun on a seasonal basis. In addition, because the Earth's yearly orbit is not circular but elliptical, the intensity of the Sun's energy, which again ionizes the upper atmosphere and hence affects communications, varies with the seasons of the year. In general, the E, D, and F layers are affected, although the F2 layer only minimally. Ion density in the F2 layer tends to be highest in winter, and less in summer. During the summer, the distinction between F1 and F2 layers is less obvious.

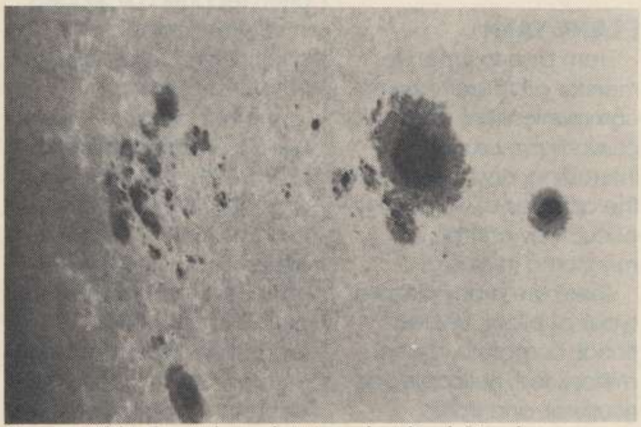
11-Year Sunspot Cycle: The number of sunspots, statistically averaged, varies on an approximately 11-year cycle. Because of that, the ionospheric effects that affect radio propagation also vary on an 11-year cycle. Radio propagation in the shortwave bands is best when the average number of sunspots is highest.

IONOSPHERIC DISTURBANCES

Disturbances in the ionosphere can have a profound effect on radio communications . . . and most of them (but not all) are bad. Let's briefly examine some of the more common forms.

Sporadic E-Layer. A reflective cloud of ionization sometimes appears in the E-layer of the ionosphere; that layer is sometimes called the E_s layer. It is believed that the E_s layer forms from the effects of wind shear between masses of air moving in opposite directions. That action appears to redistribute ions into a thin *radio reflective* layer. Sporadic-E propagation is normally seen as a VHF phenomenon, with most activity occurring between 30 and 100 MHz, and with decreasing activity up to about 100 MHz. However, about 33% of the time, sporadic-E propagation is possible on frequencies down to 10 or 15 MHz. Reception over paths of 1400 to 2600 miles is possible in the 50-MHz region when sporadic-E is present. In the northern hemisphere, the months of June and July are the most prevalent sporadic-E months. On most days when sporadic-E is present, it lasts only a few hours.

Sudden Ionospheric Disturbances (SID's). The SID, or "Dellinger Fade"—the sudden loss of signals on sunny-side receivers—rarely gives any warning. A SID can last from a few minutes to many hours. It is believed that SID's occur in correlation with solar flares (bright solar eruptions) that produce immense amount of ultraviolet radiation that impinges on the upper atmosphere. A SID causes a tremendous increase in D-layer ionization, which accounts for the radio-propagation effects.



Sunspots (like those shown here) are localized disturbances on the surface of the Sun that face the Earth only during a portion of the month.

The ionization is so intense that all receiver operators on the sunny side of the Earth experience profound loss of signal strength above about 3 MHz. It is not uncommon for receiver owners to think that their receivers are malfunctioning when that occurs. A SID is often accompanied by variations in terrestrial electrical currents and magnetism levels. Note that while HF communications fade during SID's, VLF signals are enhanced.

Ionospheric Storms. The ionospheric storm appears to be produced by an abnormally large rain of atomic particles in the upper atmosphere, and are often preceded by SID's some 18- to 24-hours earlier. Those storms tend to last from several hours to a week or more, and are often preceded by two days or so by an abnormally large collection of sunspots crossing the solar disk.

Storms occur most frequently, and with greatest severity, in the higher latitudes, decreasing toward the Equator. When the ionospheric storm begins, shortwave-radio signals may begin to flutter rapidly and then drop out altogether. The upper ionosphere becomes chaotic, turbulence increases, and the normal stratification into layers or zones diminishes.

Radio propagation can come and go over the course of the storm, but it is mostly dead. An ionospheric storm is worldwide. It is noted that the maximum-usable frequency (MUF) and critical frequency tend to reduce rapidly as the storm commences.

OBSERVER NEWS

Eighth-grader Jennifer Lieber of Florida was reported a science fair winner in the April 1993 issue of a newsletter titled "The Radio Observer" (C/O Bob's Electronic Service, Attn: Robert M. Sickels, 7605 DeLand Avenue, Fort Pierce, FL, 34951). She used a circuit similar to that shown in Fig. 1 to monitor solar-flare activity by observing the signal of radio station WWV. The recorded signal strength will be relatively smooth for a "quiet" solar day, ragged for an "active" solar day, and will take a very large dip, lasting several hours, for a serious disturbance such as a SID.

SID's (which can last from a few minutes to several hours) are believed to occur in correlation with solar flares (bright solar eruptions) that produce immense amounts of ultraviolet radiation and causes a tremendous increase in D-layer ionization.

Other observers use very low frequencies (VLF's) between 10 kHz and 60 kHz (with 20 to 30 kHz being best) to look for daylight SID's.

The American Association of Variable Star Observers Solar Division (P.O. Box 5685, Athens, GA, 30604-5685) maintains an amateur SID-observer network. The AAVSO has designed a VLF receiver for SID observations. (Contact me at the address at the end of this column for details on the receiver and how to obtain a PC board and parts for it.)

Still other observers listen for radio signals called *whistlers.* Gary Eggleston covered that phenomenon in a July, 1993 **Popular Electronics** article entitled "The Sky Chorus." And a receiver for monitoring whistlers appeared in *Science Probe!* in July, 1992.

If you or someone you know is interested in science-fair activities, then you might want to see my book *The Art of Science* (HighText Publications, 125 N. Acacia Avenue, Suite #110, Solana Beach, CA 92075). It has a chapter on advice for winning science fairs. The last time that I checked, B. Dalton and other national booksellers were stocking the book; telephone orders are available through the Independent Publishers Group at 800-888-4741.

If you are interested in radio solar observations, whether or not for science fairs, write to me (at P.O. Box 1099, Falls Church, VA, 22041) for a free bibliography. Enclose a #10 (business size) self-addressed stamped envelope (SASE) with two first-class postage stamps. ■

SCANNER SCENE

By Marc Saxon

Listen! Up in the Sky!

Uniden Bearcat's *BC-700A* mobile/base scanner offers an interesting mix of features. The unit covers 29–54, 108–174, 406–512, and 806–956 MHz. The cellular bands are locked out at the factory.

There are 50 memory channels and 12 separate search bands. Front-panel buttons allow for instant scanning of pre-programmed police, fire, aeronautic, marine, and weather channels. You can also program some of your own favorite frequencies into the police- and fire-service features. There's also a special 20-slot service-search button for private channels. You can use it to program your 20 favorite high-interest frequencies for instant access and concentrated monitoring.

HOLD
UP
DOWN
800 MHz
uniden
BEARCAT
BC700A
SQ
PRIVATE
FIRE/EMG
AIR
VOLUME
POLICE
WX
MRN
SEARCH
L/O
BAND
PROG
OFF

The Uniden Bearcat BC-700A scanner offers a novel mix of features.

Super Turbo Scan allows the BC-700A to scan and search at approximately 100 channels per second. Uniden claims that that is about five times faster than any standard scanner.

The Bearcat BC-700A is available through Uniden's large dealer network.

PLANE TALK

From time to time, we monitor pilots exchanging communications. Those discussions are usually interesting, and, because of the altitudes at which they occur, they can be monitored from afar.

There are many different types of pilots—recreational, corporate, airline, military, test, helicopter, agricultural, and traffic reporter, to name a few—and they sometimes need to communicate with others of their ilk as they fly. At other times, the communications are strictly for enjoyment.

You might enjoy hearing airline pilots on 123.45 MHz discussing things such as looking for jobs at other airlines. Or you might monitor a practice dogfight by USAF pilots on 314.2 MHz. All communications between 225 and 400 MHz are military, and in AM mode.

Helicopters have been monitored on 123.025, 123.05, 242.4, and 244.2 MHz. Other formal and informal air-to-air communications can be heard on 122.75, 122.925, 123.25, 123.45, 138.30, 141.80, 141.90, 226.1, 226.2, 234.5, 234.55, 242.7, 270.0, 271.5, 289.7, 300.6, 303.0, 313.5, 314.2, 333.3, 376.025, and 388.75 MHz. There are many more nationally used frequencies, of course. Still, these are the ones on which we have noted recent activity, those most often reported by readers in different parts of the country, and some taken from official listings.

Another aeronautic frequency worth monitoring is 122.95 MHz. This is the unicom channel used at virtually all major American airports. You are likely to hear corporate jets approaching the field requesting special arrangements when they land, such as stretch limos to meet the plane on the tarmac. Or they ask for reservations to be made for luxury-hotel accommodations. I have heard celebrities arriving via private jet using 122.95 MHz when they ask airport security to meet the plane.

Finally, several months ago we ran the communications frequency used in southern California by Air Combat, a private company that owns several older military, prop-driven, training aircraft. For a fee, Air Combat's trained, veteran combat pilots take adventure-seeking passengers aloft for simulated aerial dogfights.

When we ran the West Coast frequency in this column, we mentioned that there was an Air Combat activity in the New York City area, but we didn't have the frequency. A letter from E. Magnusson of Babylon, New York, confirms that frequency as 131.25 MHz and

Relm Communications' UC-2200 is one of the many popular, low-cost VHF handhelds being offered to the general public.

tells us that the company operates from Republic Airport on Long Island.

EVERYBODY WANTS TO TALK

The two-way radio market offers to the general public an abundance of handheld transceivers. For the most part, those are relatively inexpensive units that put out about 2 watts. Most operate on a single frequency, but some can operate on two channels.

These radios are produced in considerable quantities by many manufacturers, and are marketed through electronics stores as well as automotive-supply, camping, army/navy, building-supply, sporting-goods, and general-merchandise stores. They have proven popular with the public for every possible type of application, from security to construction, and from hunting to emergency services.

Few of these sets appear to be used with any call signs, so you can assume that people often don't bother to obtain the FCC licenses required to use them legally. As far as your scanner is concerned, it makes little difference. While the communications range might be only a mile or two, you are welcome to punch up their frequencies and listen to what everybody has to say.

The standard choice of frequencies offered lets users select one or two from the trio of 151.625, 154.57, and 154.60 MHz. Scanner owners can run all of those and put an ear out on whatever there may be to hear. Very often it's quite surprising!

Don't tell anybody this: We have heard of more than one law-enforcement agency that use two-way radios for surveillance work. That's because they assume that the people who monitor their frequencies won't be listening for police chatter there! A safe bet, we would say.

FROM OUR READERS

From an anonymous reader in Mississippi, we learned several frequencies used by Walt Disney World in Orlando, Florida. Epcot Center is on 462.65 MHz; security on 461.30; special events on 464.40 MHz; the monorail on 462.595 MHz; and 20,000 Leagues is on 151.895 MHz.

Ned Peletier of Indianapolis, Indiana, advises that the Indiana State Prison's work release program uses 155.58 MHz. Boston, Massachusetts reader S. Weinberger lets us know that the Boston Fire Department is heard on 453.65 and 483.1625 MHz.

We always enjoy receiving reports, frequencies, and comments from our readers. Our address is *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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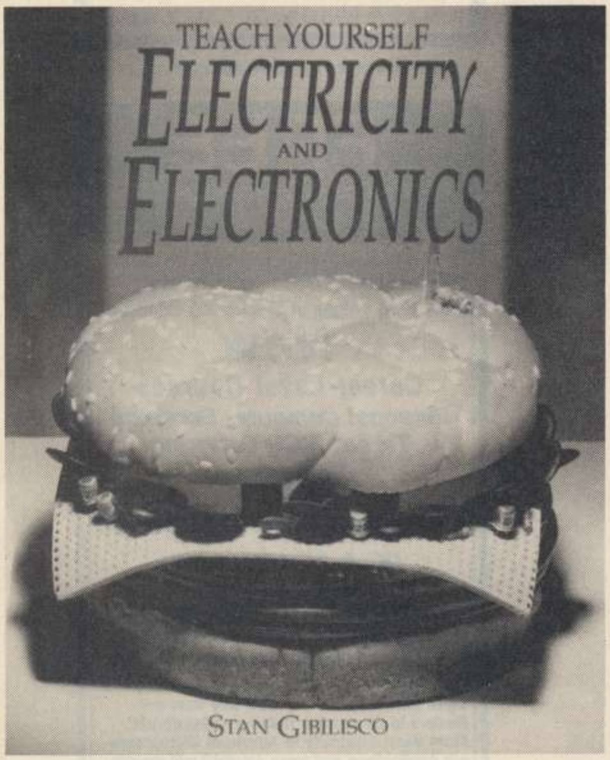
Teach Yourself Electricity and Electronics

by Stan Gibilisco

Written for those who want to learn basic electricity and electronics, but would rather not take a formal class, this book provides a do-it-yourself training course complete with quizzes and final exams. Its more than 600 pages are filled with information on AC, DC, capacitance, semiconductors, oscillators, transistors, resistors, impedance, inductance, amplifiers, power supplies, basic digital principles, integrated circuits, data-storage media, and more.

The book starts out with simple, general concepts and builds upon those to present more specialized topics in later chapters. At the end of each chapter is a 20-question, multiple-choice quiz; answers appear at the end of the book. The author recommends that readers correctly answer at least 18 of those questions—ensuring an understanding of the material—before moving on to the next chapter. The book is divided into three sections: direct current, alternating current, and basic electronics. Each section concludes with a 50-question, multiple-choice exam. Three 100-question "final exams" appear at the end of the book.



No previous mathematical or scientific training is required. The book has an easy-to-read, tutorial style, with plenty of helpful diagrams and illustrations. Standard circuit-diagram notations and symbols are introduced gradually so that their meanings will be obvious to readers.

Teach Yourself Electricity and Electronics costs $26.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel: 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

MAGIC ELECTRONIC PROJECTS

by R. Bebbington

A lot of the electronics that we take for granted today would have been considered "magical" a few decades ago, and when they are used in an unexpected way—as part of a magician's routine—they can still seem wondrous. You can conjure up lights, sounds, and movements that will puzzle your friends and family with the projects presented in this book. Most of the circuits are easy to build and help to introduce the reader to such electronic basics as series and parallel circuits, sensors, LED's, multivibrator and Hartley oscillators, Schmitt triggers, NAND-gates, and decade counters. The circuits add some sparkle to standard magician's tricks, and represent a few more unusual ones as well. Grouped under clever chapter headings like "LED Astray" and "Switchcraft," projects include the Magic Bracelet, Wireless Wonders, Indian Rope Trick, and Magic Wand.

Magic Electronic Projects
R. BEBBINGTON

Magic Electronic Projects (order no. BP334) is available for $6.25 plus $2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

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YOUR RTTY/AMTOR COMPANION

by Steve Ford, WB8IMY

There's more to HF operating than phone or CW. This book invites you to explore the world of HF digital communications. Radio teletype (RTTY), and Amateur Teleprinting Over Radio (AMTOR) offer relaxed, conversational communications; rare DX contacts; challenging contests; public-service operations; and more.

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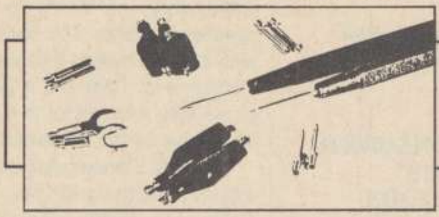

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never operated RTTY or AMTOR before, the book uses no complicated technical jargon. Instead, the focus is on practical information that you can put to use immediately. The book shows how to assemble your own RTTY/AMTOR station, and how to use RTTY and AMTOR to talk to amateurs around the world. It explains how to hunt for digital DX and how to compete in RTTY/AMTOR contests. New modes such as PacTOR and CLOVER also are covered, and the book discusses exchanging messages and files on the worldwide AMTOR APLink systems. In addition, a handy reference section points you to sources of books, newsletters, equipment, and software. An extensive glossary defines the lingo unique to RTTY and AMTOR.

Your RTTY/AMTOR Companion costs $8 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111; Tel: 203-666-1541; Fax: 203-665-7531.

CIRCLE 93 ON FREE INFORMATION CARD

REPAIRING IBM PCs AND COMPATIBLES: An Illustrated Guide

by Michael F. Hordeski

Written for anyone who uses, manages, maintains, or repairs PC's, this book is based on the philosophy that the better your understanding of your computer's design and operation, the easier it is to discover when and why they are not working correctly. With that aim in mind, the book thoroughly explains the architecture of the IBM-PC families and compatible computers, defines common buzzwords and acronyms, and details effective troubleshooting techniques.

By learning how to maintain your system, you can reduce downtime and its inherent costs. Packed with time- and money-saving diagnostic and repair tips, the book explains the many ways that a PC can fail, how to detect those failures, and how to make the appropriate repairs. Data disasters as well as hard-drive difficulties are covered. The book teaches readers how to use diagnostic software programs to fix hard drives before major problems occur and to recover data that DOS cannot read. It explains how to test processors, memory, hard disks, mouse devices, networks, and power supplies without using special equipment. A wealth of illustrations and photographs supplement the text.

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SMALL MOTOR, GEARMOTOR AND CONTROL HANDBOOK

from Bodine Electric Company

Now in its fifth edition, this authoritative reference source of complete information about fractional horsepower motors and motion-control systems has been revised and expanded to more than 280 pages. The book provides design engineers, distributors, and service personnel with the information they need to safely select the right product for various applications, and is used by students at many colleges and vocational schools throughout the country.

The handbook offers selection and application guidelines for AC motors and gearmotors, brush-type DC motors, brushless DC motors and gearmotors, motor controls, and special-purpose motors. New to this edition are feedback devices, clutches, and braking techniques. More than 100 engineering diagrams and technical illustrations, as well as charts, graphs, and photos, help clarify the technical data. Twelve appendices offer additional reference data, including a list of troubleshooting tips, resistor-value codes, motor-application formulas, associations and standards organizations, conversion charts, and international voltage and frequency standards.

A brief quiz, designed to test readers' comprehension of the material, is included. Completed quizzes can be mailed to Bodine for grading; those who score 85% or better will receive a Certificate of Completion in recognition of their achievement.

The Small Motor, Gearmotor, and Control Handbook is available for $10 ($11.00 outside the U.S.) from Bodine Electric Company, Marketing Communications, 2500 W. Bradley Place, Chicago, IL 60618; Tel: 312-478-3515; Fax: 312-478-3232.

CIRCLE 92 ON FREE INFORMATION CARD

THE U.S. CONSUMER ELECTRONICS IN REVIEW: 1993 EDITION

from the Electronics Industries Association

Published by the Consumer Electronics Group of the Electronics Industries Association (EIA/CEG), this annually updated brochure reports to the public the achievements, breakthroughs, milestones, and trends in the diverse field of consumer electronics. Virtually every type of consumer product is covered, including audio and video components and systems, home-theater systems, telephones, fax machines, answering machines, accessories, computers and peripherals, multimedia and CD-ROM, mobile electronics, assistive devices, personal-electronics items, home security, and home automation.

THE U.S. CONSUMER ELECTRONICS INDUSTRY
IN REVIEW
1993 EDITION
ENTERTAINMENT & EDUCATION
YESTERDAY TODAY & TOMORROW

The 94-page booklet describes the items contained in each product category, and explains how they work and what they are used for. A wealth of statistical information—presented in the form of tables, charts, and graphs—depicts the annual growth in sales and household penetration of most major product categories. Discussions of product development and marketing trends—the direct result of analyzing the statistical data—is included. A detailed history of consumer electronics is provided, along with a time line of significant events. The book also offers a look at industry highlights for 1992 and a listing of industry sources for those who need further information.

The U.S. Consumer Electronics Industry In Review: 1993 Edition is available (single copy only) free. Send a self-addressed, stamped ($1.44 postage), 6 × 9-inch envelope to Electronic Industries Association/Consumer Electronics Group, 2001 Pennsylvania Avenue NW, Washington, DC 20005-1813; Tel: 202-457-8700; Fax: 202-835-8939. In quantities of 2–49, the booklets cost $1.50 each; 50–99, $1.25 (EIA members subtract 10-cents per copy). ■

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NEW PRODUCTS

Rock Solid Style

Speakers have been getting smaller and smaller, but for the most part, they've retained the same old box shape. One eye-opening exception is the three-piece *Ovale* subwoofer/satellite system from *Rock Solid Sounds*. Two tiny, magnetically shielded midrange/tweeter speakers, each have a 2¼-inch full-range driver. The futuristic, spacy-looking oval speakers, each set atop an adjustable "stalk," can be angled in any direction. They can be wall or ceiling mounted, or can sit on a shelf. The rounded subwoofer, fired by twin 160mm bass drivers, extends the system's output into the deep-bass region (to below 50 Hz). Power-handling peaks at 100 watts. The system is available in either matte black or white. Together, the three pieces form a full-range stereo, or round out a home-theater system, wherever space is at a premium and styling counts.

The Ovale subwoofer/satellite system has a suggested retail price of $399. For additional information, contact Rock Solid Sounds, P. O. Box 8, 54 Concord Street, North Reading, MA 01864-0008; Tel: 508-664-3406 or 800-370-3742; Fax: 508-664-4109.

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If you're worried about electromagnetic radiation, poor antenna performance, or EMI/RFI, *I.C. Engineering's Digi-Field* field-strength meter can help put you at ease. With its frequency response of DC up to 12 GHz, it readily detects potential electromagnetic radiation hazards. Digi-Field can easily find 60-Hz AC-line interference, as well as RFI/EMI instrumentation-disrupting setups. The handheld instrument can also be used to check antenna gain/loss and polarization patterns. All measurements are displayed on the unit's 3½-digit LCD readout, allowing the user to make quick visual checks of radiation gain or loss, antenna patterns, garage-door opener transmitters, microwave oven leakage, and cellular and portable phones, and to locate transmitters. The battery-powered meter also has a detector output jack for AM monitoring. The Digi-Field can be used with its own telescoping antenna or with an external one with a PL 259 connector. Typical calibration curves in dBm are available.

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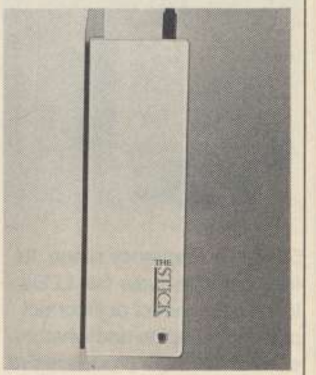
CIRCLE 101 ON FREE INFORMATION CARD

LINE-SHARING DEVICE

Home offices and small businesses often have fax machines and modems, as well as the usual telephones and answering machines. Getting separate phone lines can be an expensive proposition. *The Stick* from *Multi-Link* alleviates the need for separate phone lines by integrating fax, modem, and voice equipment on one existing line and routing incoming calls to the appropriate device. The Stick offers a feature that allows the user to "grab" a call and control the Stick from an extension phone that isn't directly connected to the device. The Stick is compatible with virtually all Key and PBX multi-line phone systems and can be used to expand a designated



"fax" line to include voice and modem calls. Calls can be manually transferred between data and voice equipment by either the caller or the receiving party, using touch-tone security access codes that provide a high degree of protection from computer hackers and junk-fax transmissions. All programming can be done using a touch-tone phone, or the user can take advantage of factory-direct preprogramming.

The Stick line-sharing device has a suggested retail price of $119. For further information, contact Multi-Link Inc., 225 Industry Parkway, Nicholasville, KY 40356; Tel: 606-885-6363 or 800-535-4651; Fax: 606-885-6619.

CIRCLE 102 ON FREE INFORMATION CARD

MOTOR- AND PHASE-ROTATION TESTER

Extech's Model 480303 combines a three-phase rotation tester and a motor-rotation tester in one handheld instrument. The three-phase rotation tester accepts an input voltage from 100–600 VAC for testing the phase orientation of three-phase power sources over the 50–70-Hz frequency range. Its front panel features five LED's to indicate correct or incorrect phase orientation and whether each of the three phases is live. The motion-rotation tester measures the rotation direction of motor shafts to insure that the motor is not damaged due to incorrect wiring. The device comes with test leads and three large alligator clips.

The Motor and Phase Rotation Tester costs $99. The Phase Rotation Tester (*Model 480300*) is also available without the motor tester for $59. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel: 617-890-7440; Fax: 617-890-7864.

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VOICE-DIALING TELEPHONE

Using state-of-the-art voice-recognition technology, the *DUoFONE-600* voice-dialing telephone from *Radio Shack* allows the caller to simply say the name of a person previously stored in the voice directory, and the phone dials the number. The phone is "taught" to recognize each spoken name and the associated number. It then makes a voiceprint for each name and number. Twenty voice-dial numbers can be stored in the voice directory, and an additional 50 speed-dial numbers can be stored separately.

If more than one person uses the voice-dial feature, each must create their own voiceprint. Names and numbers can be stored in any language.

The DUo-FONE's display window and three option buttons make it easy to store and review names and numbers, set features such as tone or pulse dialing, and enter a private security code to prevent others from changing or searching the phones directories. A dial lock restricts all outgoing calls except those made by pressing three pre-selected single-touch memory keys, which can be programmed with emergency numbers. Other features include a microphone mute for privacy; an adjustable display showing the time, date, and time elapsed during a call; last-number redial; line-status indicator; hold; and a flash button for custom calling services such as Call Waiting or 3-Way Calling.

The DUo-FONE-600 (Cat. No. 43-650) sells for $139.95 at Radio Shack stores nationwide. For further information, contact Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.

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BENCH-STYLE DIGITAL MULTIMETER

The 4000-count, bench-style *Model 2835* from *B+K Precision* is a full-featured multimeter/capacitance meter/frequency counter with a basic DC voltage accuracy of 0.5%. Multimeter functions include the measurement of resistance and AC/DC voltage and current, and diode and continuity checks. Frequency measurement extends to 1 MHz, with up to 1-Hz resolution, and capacitance measurement is to 40 µF with up to 1-pF resolution. The Model 2835 features autoranging or manual ranging operation and a high-contrast back-lit LCD readout with 42-segment bargraph.

Designed for bench or field use, the instrument offers AC or battery operation, with battery life rated at 1800 hours. The compact unit has convenient built-in storage for test leads and AC power cord. High-energy fusing, overvoltage protection, and an impact-resistant case provide protection against accidental misuse. The DMM comes with test leads, power cord, hand and neck straps, and user's manual.

The *Model 2835* digital multimeter costs $270. For further information, contact B+K Precision, Maxtec International Corporation, 6470 West Cortland Street, Chicago, IL 60635; Tel: 312-889-9087; Fax: 312-794-9740.

CIRCLE 105 ON FREE INFORMATION CARD

DELUXE EUROPEAN TRANSLATOR

The slim, pocket-sized *European Translator Deluxe Edition (TR-3000)* from *Seiko Instruments* instantly translates more than 40,000 words, including 8000 words and phrases in each of five languages: English, French, Spanish, German, and Italian. Words in all five languages are based on The Random House dictionaries. Commonly used phrases are divided into 12 categories, including directions, hotel and restaurant, shopping, transportation, and emergency, that can be accessed by pushing a button. The translator features a QWERTY-style keyboard, a metric converter, and a calculator with currency converter.

For easier reading, the TR-3000's two-line, dot-matrix display changes to a single-line, large-character display by pressing a key. The large-character display can be scrolled for viewing long words. Condensed operating instructions are printed on the inside of the unit's folding lid.

The European Translator Deluxe Edition has a suggested retail price of $99.99. For more information, contact Seiko Instruments USA Inc., Consumer Products Division, 2990 West Lomita Blvd., Torrance, CA 90505; Tel: 800-873-4568. ■

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BIPOLAR TRANSISTORS

(Continued from page 48)

Since a high-value resistor is used to change the output voltage to a current (I = V/R) in a class-A configuration, the output current is small. That is important since current flows at all times in such amplifiers, with or without an input signal. Power is wasted and efficiency (the ratio of output to total power consumed) is low—only about 20 to 25%—in class-A amplifiers. Class-A amplifiers can be configured for single-ended or push-pull operation and are used in AF (audio-frequency), IF (intermediate-frequency), and RF (radio-frequency) applications.

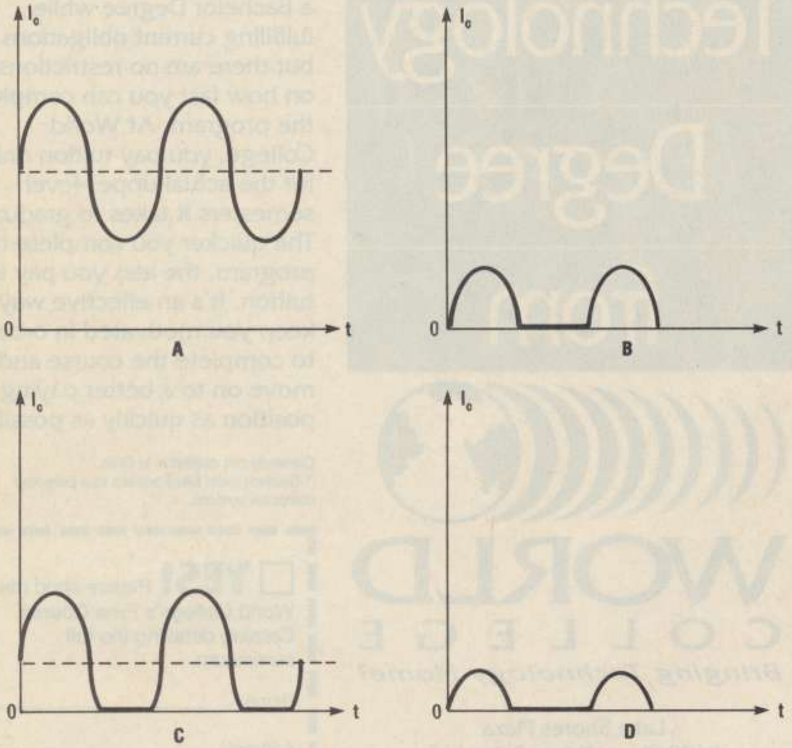

Fig. 5. In a class-A amplifier, the transistor is biased so that it is always turned on (see waveform in A). In class-B operation, the transistor is biased at cutoff (B). Class-AB amplifiers (C) are biased somewhere between class-A and class-B units (D).

Class-A operation is suitable for voltage amplifiers. In a voltage amplifier, the emphasis is on the magnitude of the output voltage. Figure 6 shows a single-ended class-A audio-frequency voltage amplifier. Such an amplifier might be used in a preamplifier stage, where input signals are typically small, and a faithful reproduction of the input using a single transistor is needed. That configuration allows a small input current to control current drawn from a power source, and thus produce a stronger replica of a weaker original signal.

In class-B operation, the transistor is biased at cutoff (see Fig. 5B), so that output current flows during only half of the input cycle. It is used where high efficiency and low distortion are required—for instance, in audio power-output configurations. When the class-B amplifier is used for audio applications, two such amplifiers connected in the push-pull configuration are required, so that current can flow alternately through the two amplifiers. In other words, one amplifier is turned on while the other is turned off.

On the other hand, when the class-B amplifier is used in RF applications, it can be configured for single-ended operation. Since, in the absence of an input signal its current output is negligible, it is used where high efficiency (60–70%) and low distortion are required, which is very important in high-power amplifiers.

Class-AB amplifiers (see Fig. 5C) are biased somewhere between class-A

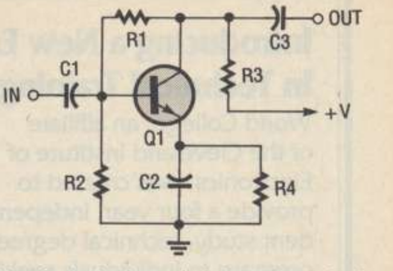

Fig. 6. A single-ended class-A audio-frequency voltage amplifier, like this one, might be used in a preamplifier stage, where input signals are typically small and a faithful reproduction of the input using a single transistor is needed.

and class-B operation, and have efficiencies (25–35%) and distortion characteristics that lie between those of class-A and B amplifiers. Class-AB amplifiers require a somewhat larger input signal than do class-A amplifiers. The class-AB amplifier is used in push-pull configurations for both audio- and radio-frequency applications.

In class-C operation—which has the highest efficiency (perhaps more than 90%), but offers the greatest distortion—the transistor is biased beyond the cutoff region (see Fig. 5D). Because of that, output current flows during less than half (about a third) of the input cycle, making it unsuitable for amplifying signals of varying amplitude, such as audio. That type of amplifier is normally used to amplify a signal of fixed amplitude; for instance, it is often used in the RF power output stages of a transmitter. Current in a class-C amplifier flows in a series of power pulses that excite an LC-tank circuit into oscillation. Because of that the output waveform is a sinewave, that varies in amplitude if modulated. Class C amplifiers can be configured for push-pull or single-ended operation. Table 1 summarizes the conduction angles and efficiency ratings of the various classes of transistor amplifier. ■

Programing your VCR
Mick

TELEPHONE INTERFACE

(Continued from page 63)

junction of the two resistors. The playback position is the junction of the 47k resistor and the transformer's lower left lead.

Put a piece of electrical tape across the transformer leads (resistor end). That helps to protect things when closing the cover, forcing the switch down into that space. To close the cover start by hooking the jack hole on the cover over the end of the jack on the case. Carefully press the box cover down. You may have to fuss with the wires slightly to close the box completely. If everything went well, the cover should easily close and stay shut.

Modifications and Limitations. You can build the circuit into anything you want including a telephone itself. Any good 600:600-ohm audio transformer will work. The one used in the prototype (which measured 0.6 × 0.6 X 0.5 inches) fits nicely into the telephone-jack housing.

Be careful when placing audio on the phone line. The device has plenty of capacity to handle audio. The biggest limitation is the phone company. They simply clip audio when you try to get past a certain level. It will start to distort. The best thing to do is adjust your audio output so that you hear it in your earpiece just a little louder than normal. That should be plenty of level for someone on the other end.

You can leave the unit plugged into the phone line all the time! It will protect your audio equipment from ring voltages while protecting the phone line from your equipment. However, when you are connected to a low-impedance source, like an 8-ohm output from a cassette recorder, it will load down the line to audio. If you try phoning out using a lesser-quality tone-dialed phone, it may not have enough oomph to overcome the loading effect. The simple answer is to leave the audio plug out until you've established your connection and are ready to play the audio on the line. When the audio jack is plugged into a high-impedance input such as a microphone input on a tape recorder, you will not have that problem. It can be left in that condition all the time.

The unit will not work with digital telephone lines. You must have an analog signal path available.

Testing and Adjustments. Just plug the modular plug into your wall jack, plug the phone into the jack on the case. Plug the audio cable into a cassette's microphone input or any medium-to-high impedance input. Put a tape in the recorder, and the recorder in the record/pause mode. Press "one" on the phone to kill the dial tone or simply call someone and record the conversation.

Make sure you have the switch on the coupler in the correct position. You want the audio cable connected to the junction of the 47k and the 4.7k resistors through the switch for a microphone-input recording. The resistor divider just drops the audio down to a level that the automatic-level control in the tape recorder can handle. The full audio level (other switch position) would totally overdrive a microphone input.

Playback the cassette normally (not on the phone line yet) and listen for any hum that was not on the original audio. The cause of any hum will probably be the junction of the two resistors touching something. That is an extremely sensitive point. It should be totally insulated. That is why we recommend putting a piece of electrical tape on the transformer before soldering the resistors to it.

If the audio sounds good then remove the jack from the microphone input and place it in the headphone output. Change the switch position on the unit. You may have to leave the audio plug out until you make a call or at least get rid of the dial tone by pushing one button on the phone. Rewind your tape and play it. Listen on the phone. Adjust the audio level as described and you are done. ■

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CIRCUIT CIRCUS

(Continued from page 71)

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RESISTORS

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R1, R2—22-megohm
R3—2200-ohm

ADDITIONAL PARTS AND MATERIALS

C_X—See text
TP1–TP3—Metal contacts (see text)
Perfboard materials, +12-volt power source, IC socket, wire, solder, hardware, etc.

By bridging the TP1 and TP3 contacts, or the TP2 and TP3 contacts, C_X can be added or removed from the oscillator circuit. A number of similar latching circuits can be added to the oscillator circuit to form a touch-controlled range switch.

That does it for this month. Until we meet next time, have fun experimenting with the 4093. ■

ANTIQUE RADIO

(Continued from page 65)

manual for an obsolete Radio Shack model COMP-100 "programmable-memory scanning receiver"? Reader *Nathan Kendall* (Box 546, Kingston, N.S., B0P 1R0, Canada) needs a source of information and schematics for a General Electric model C403 and other "made-in-Canada" radios. *Don Gagnon* (HCR 579-B, Payson, AZ 85541) requests a schematic for a Sharp stereo cassette deck model RT11654. Sharp can no longer supply it.

Reader *Jim Lowe* (1521 Scenic Drive, Pasadena, CA 91103) is a retired radio-broadcast engineer with a '50-year career. He was also the first drum major of the Tournament of Roses band, and led the Pasadena Rose Parade from 1930 to 1935. Jim is looking for broadcast microphones of all types, and would also like to acquire a crystal set (the old-fashioned type using a "cat's whisker").

John H. Rodriguez (132 Colonel's Lane, Weymouth, MA 02189) is looking for alignment instructions for a Realtone "Globepacer." He also needs a replacement power transformer (Thordarson Meissner 23V118 or equivalent) for a Lafayette 19-0915 or 19-0516 stereo amplifier. Once the amp is running, he needs some assistance in hooking it up to an AM/FM tuner.

Before we close, I'd like to thank reader *Craig Sellen* (Waymart, PA) for those Theremin articles!

Until next month, write me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

BUILD A JOYSTICK ADAPTER

(Continued from page 38)

2. Make sure that the software you're running supports joystick inputs and you have installed the NinJA in the appropriate joystick port as dictated by the software if your computer has multiple ports.

3. If you are using the NinJA-15 with a program that expects an analog input, you will see erratic screen movement. Try a different program!

4. If you are using a NinJA-15, make sure that you have followed any software-calibration instructions given for the particular program you're running; some programs require you to move your joystick left/right/up/down/center hitting a button occasionally. That can be avoided if the program recognizes "digital" joysticks, which the NinJA-15 (with its connected Nintendo joystick) essentially is.

5. If possible verify the proper operation of your Nintendo joystick by trying it on an NES-game computer.

6. If the problem persists, try a different game card, joystick port, program, or Nintendo joystick. ■

ELECTRONS

(Continued from page 44)

observer's relative velocity. In fact, our universe works this way for an important reason: to keep physical reality constant. In other words, everything works the same, no matter how fast you may be traveling relative to someone else. Consequently, you cannot travel faster than light because light always appears to be going the same speed even if you're moving!

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WIRELESS HEADPHONES

(Continued from page 33)

functioning. The VCO tests should be made without an audio input to ensure a stable frequency reading.

Implementation and Use. The receiver may be mounted in a number of ways, depending on the user and the availability of parts. Perhaps the most obvious, but most difficult, is in a headset. The small size of the receiver circuitry facilitates proportionally small packaging, but the added mass on a light-weight headset can result in an unstable mount. Use a large-size headset (full ear enclosure) and mount the receiver and battery as low as possible to maintain a low center of gravity.

Placing the receiver and battery on opposite sides of the two speaker elements is ideal or at least more balanced. Use shielded audio cable between the two headset speakers.

An alternative packaging idea is to use a lapel mount, in which the receiver and battery are combined in a single enclosure that is separate from the headphones. The photodiode may be oriented on the printed-circuit board to permit side or front illumination relative to the printed-circuit board.

No external lens is necessary at either the receiver or the transmitter—in fact I recommend against it in order to maintain a wide field of view at the receiver end. ■

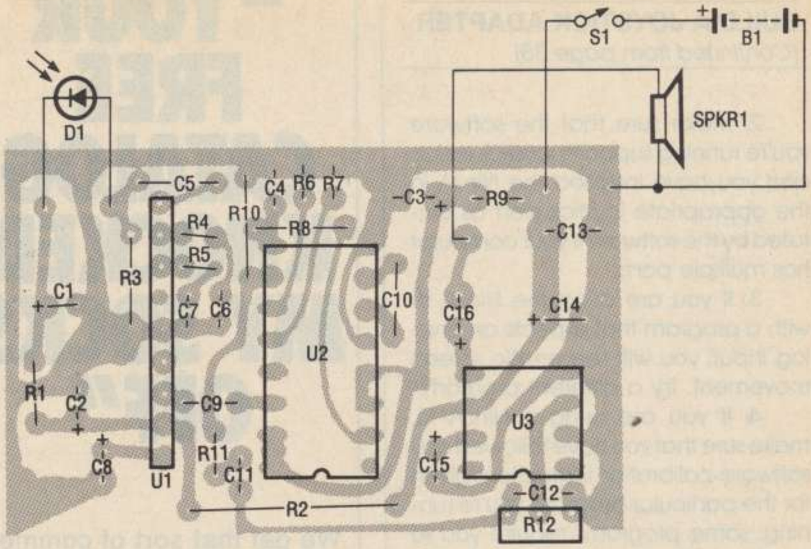

Fig. 6. The receiver's printed-circuit board should be assembled using ⅛-watt or smaller resistors and miniature (radial lead electrolytic and ceramic-disc) capacitors. The volume control (R12) can be a miniature PC-mounted potentiometer or conventional unit, which would have to be mounted off-board.

SUPER RESOURCES

(Continued from page 60)

to get it serviced, and where to find articles about modifications. Comparative feature and performance charts provide you with ammunition for your next dealer or flea-market visit. A glossary of radio features and terms is included for beginners. The Source book, published by the ARRL, is $15.

CQ Communications, Inc. has for several years offered communications buyer's guides. Presently offered are: the *CQ Amateur Radio Equipment-buyer's Guide*, which features more than 1,000 amateur radio products, specifications, and photos, as well as a manufacturer and dealer directory; and the *Popular Communications Guide*, which covers receivers, scanners, accessories, DX'ing, scanning, CB's, and antennas.

Newest is a third publication, *CQ's Guide to Amateur Radio*. Not strictly an equipment-buyer's guide, its focus is on articles written strictly for the newcomer by the best writers in amateur radio. Topics covered include licensing and upgrading information, efficiently setting up your first amateur-radio station, packet-radio and repeater operating practices and etiquette, mastering handheld radios, a small buyer's guide, a directory of manufacturers and dealers, and more. Each CQ guide is priced at $4.95 each plus $2.50 S/H.

Communications Receivers, 2nd Edition, by Ray Moore, ex-K1DBR, is an authoritative storehouse of data on American general coverage communications receivers from 1932 to 1981—especially useful if you seek an older, tube-type radio. Moore covers RME, National, Hallicrafters, Hammarlund, Collins, and others, and shows photos of 375 receivers from 58 companies. Including variations on the 375 receivers, over 700 radios are covered. The 115-page book is available for $17.95 plus $2.50 S/H from RSM Communications.

Shortwave Receivers Past and Present (a 1987 "blue book" by Fred Osterman, N8EKU) is a 104-page, illustrated directory of the vital statistics of more than 200 communications receivers manufactured over the past 20 years. It provides specifications and photos of most of the receivers it lists. Also included is a very useful chart that shows the new and the approximate used cost of each radio. It's $8.95 plus $1 S/H from Universal Radio, Inc.

Also offered by the same publisher as the *World Radio and TV Handbook* (WRTH) is the *WRTH Equipment Buyers Guide*, 1993 edition. The 160-page, $19.95 book offers authoritative test results on most modern receivers and a handy price vs. performance evaluation. The Guide also includes a used radio-equipment checklist and advice on shortwave antennas.

The Guide is distributed by Billboard Books but it's also available from radio booksellers including Ham Radio Bookstore. The Bookstore offers the guide separately or you could purchase it together with the 1993 WRTH for $34.90 plus $4 S/H. ■

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CAPTIONING

(Continued from page 54)

captioned in the proper mode, you may not see text even when someone is talking, or what you hear may not precisely match what you see. That doesn't mean that the TV set or system isn't working properly.

How Can TV Teach Kids to Read? Some families make a game out of reading the captions, particularly with shows like Mr. Rogers and Sesame Street (both early converts to captioning). Dad or Mom turns down the audio volume and assumes the role of the narrator or central figure. The small fry read the lines spoken by the other characters. Or, with the audio turned up, a parent may point to a new word in the caption as it's spoken on the screen. "Reading a favorite television program can be both an enjoyable and educational family activity," says Gary Shapiro, Vice President of the Consumer Electronics Group of the Electronics Industries Association.

If all of this sounds pretty good to you, but you don't feel like investing in a new TV set to get it, you can buy a small and attractive add-on adapter made by NCI (5203 Leesburg Pike, Falls Church, VA 22041) that offers some features not found on built-ins. The TeleCaption 4000, at $180, features a built-in tuner, the ability to record captions on videotape, and portability The TeleCaption VR-100 at $130 is virtually identical in appearance and features, but requires the use of an external TV tuner. ■

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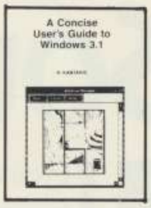

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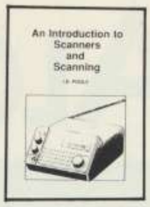

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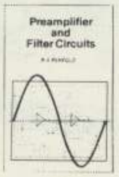

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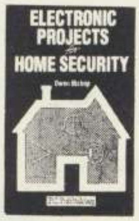

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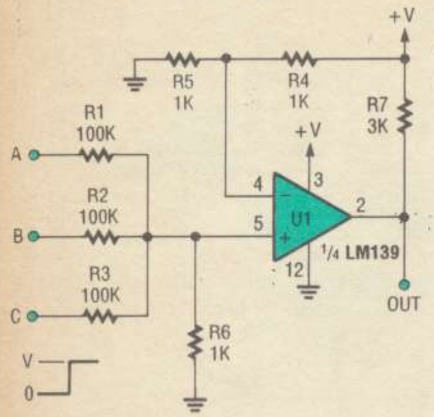
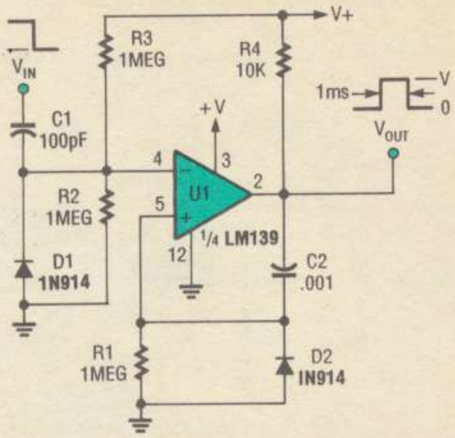

+V
R5
1K
R4
1K
R7
3K
R1
100K
A
R2
100K
B
R3
100K
C
+V
3
4
5
U1
2
12
1/4 LM139
OUT
R6
1K
V
0

ONE-SHOT MULTIVIBRATOR


V+
V_{IN}
R3
1MEG
R4
10K
1ms
V
0
V_{OUT}
C1
100pF
+V
4
3
R2
1MEG
5
U1
2
12
1/4 LM139
D1
1N914
C2
.001
R1
1MEG
D2
IN914

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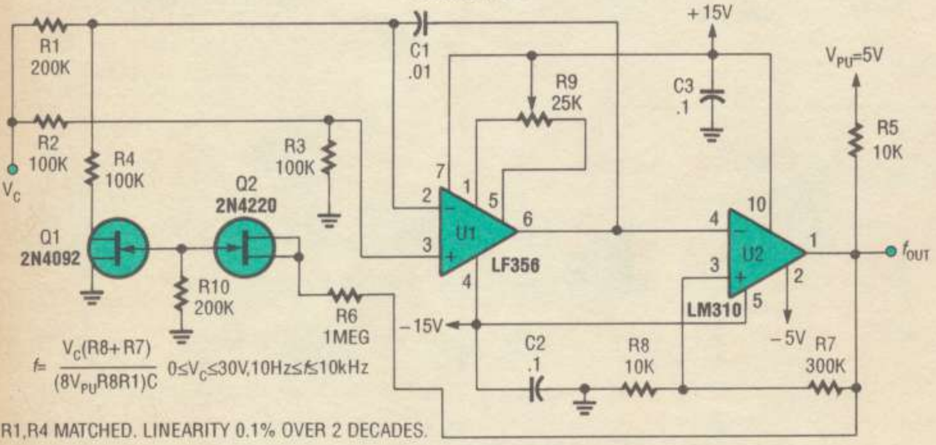
3 DECADE VCO


R1
200K
C1
.01
+15V
R9
25K
C3
.1
V_{PU}=5V
R2
100K
R4
100K
R3
100K
R5
10K
V_C
Q1
2N4092
Q2
2N4220
7
1
5
2
6
3
U1
4
LF356
10
4
1
3
U2
2
5
LM310
f_{OUT}
R10
200K
R6
1MEG
−15V
C2
.1
R8
10K
−5V
R7
300K

$f = \frac{V_C(R8+R7)}{(8V_{PU}R8R1)C}$ $0 \le V_C \le 30V, 10Hz \le f \le 10kHz$

R1,R4 MATCHED. LINEARITY 0.1% OVER 2 DECADES.

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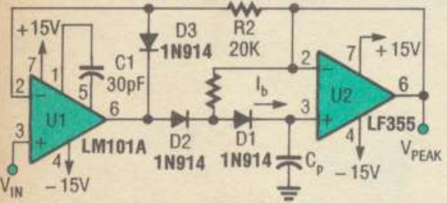
APPLICATIONS CIRCUITS

LOW DRIFT PEAK DETECTOR


+15V
D3
1N914
R2
20K
C1
30pF
7
1
5
2
6
3
U1
4
LM101A
V_{IN}
−15V
D2
1N914
D1
1N914
I_b
C_p
2
7
+15V
3
U2
6
4
LF355
−15V
V_{PEAK}

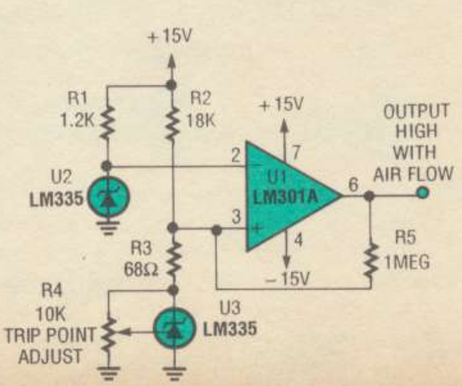
BY ADDING D1 AND R_f, V_{D1}-0 DURING HOLD MODE. LEAKAGE OF D2 PROVIDED BY FEEDBACK PATH THROUGH R_f.

LEAKAGE OF CIRCUIT IS ESSENTIALLY I_b(LF155,LF156) PLUS CAPACITOR LEAKAGE OF Cp.

DIODE D3 CLAMPS V_{OUT} (A1) TO V_{IN}-V_{D3} TO IMPROVE SPEED AND TO LIMIT REVERSE BIAS OF D2.

MAXIMUM INPUT FREQUENCY SHOULD BE << $1/2\pi R_f C_{D2}$ WHERE C_{D2} IS SHUNT CAPACITANCE OF D2.

AIR-FLOW DETECTOR


+15V
R1
1.2K
R2
18K
+15V
OUTPUT HIGH WITH AIR FLOW
2
7
U1
LM301A
6
3
4
−15V
U2
LM335
R3
68Ω
R5
1MEG
R4
10K
TRIP POINT ADJUST
U3
LM335

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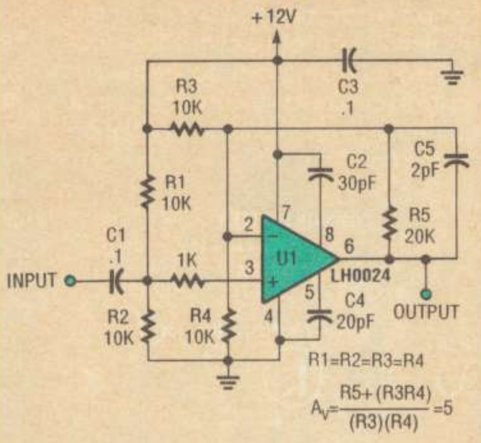
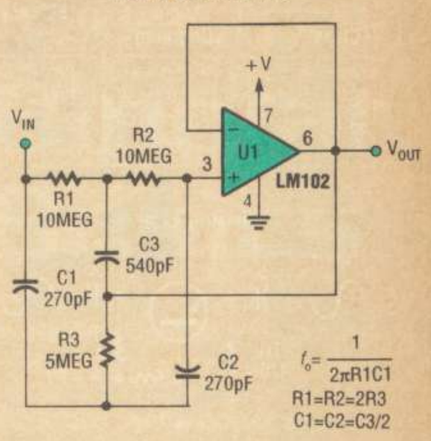

+12V
C3
.1
R3
10K
C5
2pF
C2
30pF
R1
10K
R5
20K
C1
.1
INPUT
1K
U1
LH0024
C4
20pF
OUTPUT
R2
10K
R4
10K
2
3
4
5
6
7
8
R1=R2=R3=R4
$A_V=\frac{R5+(R3R4)}{(R3)(R4)}=5$

HIGH Q NOTCH FILTER


+V
V_{IN}
R2
10MEG
U1
LM102
V_{OUT}
R1
10MEG
C3
540pF
C1
270pF
R3
5MEG
C2
270pF
3
4
6
7
$f_o=\frac{1}{2\pi R1C1}$
R1=R2=2R3
C1=C2=C3/2

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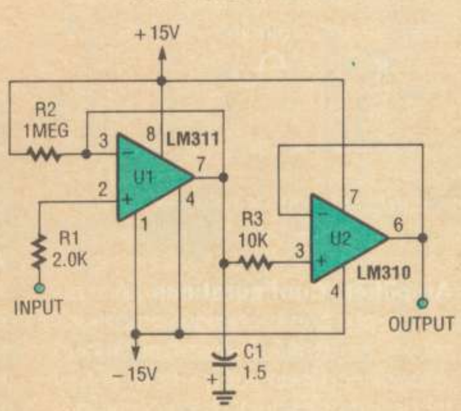
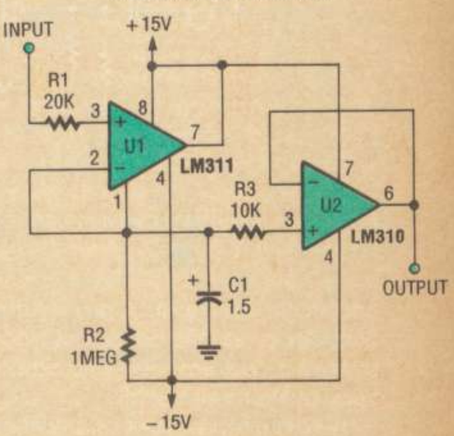
269 Popular Electronics FactCard — APPLICATIONS CIRCUITS

NEGATIVE PEAK DETECTOR


+15V
R2
1MEG
LM311
U1
R1
2.0K
INPUT
R3
10K
U2
LM310
OUTPUT
C1
1.5
−15V
1
2
3
4
6
7
8

POSITIVE PEAK DETECTOR


INPUT
+15V
R1
20K
U1
LM311
R3
10K
U2
LM310
OUTPUT
C1
1.5
R2
1MEG
−15V
1
2
3
4
6
7
8

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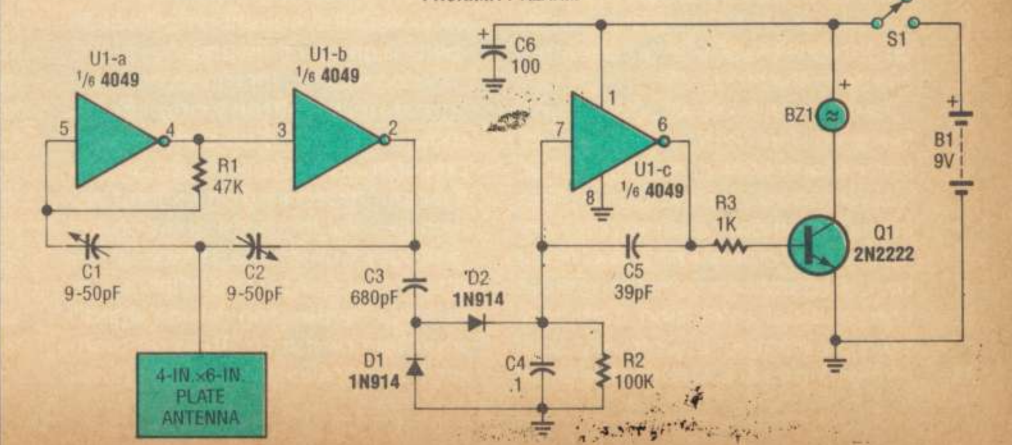
270 Popular Electronics FactCard — APPLICATIONS CIRCUITS

PROXIMITY ALARM


U1-a
1/6 4049
U1-b
1/6 4049
C6
100
S1
U1-c
1/6 4049
BZ1
B1
9V
R1
47K
R3
1K
Q1
2N2222
C1
9-50pF
C2
9-50pF
C3
680pF
D2
1N914
C5
39pF
D1
1N914
C4
.1
R2
100K
4-IN.×6-IN. PLATE ANTENNA
1
2
3
4
5
6
7
8